THE EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Biographical Memoir of M. Duhamel. By Baron Cuvier *.

M. Duhamel was one of those philosophers of the old stock, if we may be allowed to use the expression, whereof many are recorded in the history of the Academy; men who, labouring in retirement for their own pleasure, and for the benefit of their fellow creatures, regardless of fame, knew little of the world, and cared as little to be known by it; whose works the public read with advantage, unaware almost whether the authors themselves were still living, or without informing themselves at what period they lived. So great was his modesty, that notwithstanding the undoubted title which he had to speak with authority in the Academy, during a long academic career, his voice was scarcely heard among us. Many of his fellow members, perhaps, did not know him by sight, and yet he was one of the benefactors of his country; he diffused a knowledge of many useful processes; he was one of the first who introduced among us the true principles of metallurgy. All those who at the present day practise the art of mining, either derived their knowledge from him or from those whom he instructed; and the entire body of men attached to this branch of the administration, professes to recognise him as its venerable patriarch. These circumstances are surely more than sufficient to incite us all to cherish his

* Read to the Royal Academy of Science of the Institute of France on the 8th April 1822.

memory with that care which he himself too much neglected, and to influence you in paying towards him the debt of his contemporaries.

Jean Pierre-François-Guillot Duhamel, Inspector-General of the Mines, and member of the Academy of Sciences of the Institute, was born on the 31st August 1730, at Nicorps near Coutances, in the Department de La Manche, and was descended from an old family in the province.

From his earliest years, he was mild and reserved in his manners, but manifested great steadiness in his undertakings. His father, who intended him for the bar, placed him under the care of an attorney, according to the practice which had become necessary at that period, when, through the negligence and selfishness of the professors, the instruction in law to be obtained in the public schools had become utterly inefficient.

Placing him with an attorney, and at the extremity of Lower Normandy, was less likely to enable him to learn jurisprudence, than to shew him chicanery in all its deformity. Nor had the profession any charm for him. A young man of his character required another object of study; an irresistible presentiment made him think there existed more worthy occupations; and in order to seek them unrestrained, without apprising any one, he commenced making his escape from the sort of prison in which he felt that his intellect could never be expanded. He had a grand-uncle, who, after having long served as an engineer, without obtaining advancement, and after having in vain tried several other professions, resolved to put an end to his disappointments by becoming a capuchin friar. More fortunate under the frock than in the world, he had arrived at the dignities of his order—for there is no society of men, however humble, that has not dignities and baits for ambition—and at this time he was guardian of the capuchins of the city of Caen, and superior of those of the provinces. It was with him that the young Duhamel sought a refuge.

A man such as he could not be insensible to evils which he had himself experienced, nor to that restlessness so common in youth of energetic minds, so long as they have not obtained the true place assigned them by nature. He not only received his grand-nephew with a fatherly affection, but judging mental employment in the highest degree necessary, he undertook to teach him what he had formerly known of mathematics. Like those platonic souls that seek out each other as soon as they are cast into the actual world, the young attorney's clerk at length found the food that agreed with him, and seized it with avidity. Henceforth absorbed in his retreat, by this sole object of study, he soon became a more expert mathematician than his uncle.

It may well be judged, that in thus directing the attention of his nephew, the good guardian of capuchins did not intend to condemn him to his own profession. On the contrary, he busied himself in renewing his connexions with his old companions. M. Peyronnet, under the authority of M. Trudaine the elder, at that time founded the School of Bridges and Highways, which has since become so useful and so honourable to France. M. Duhamel was introduced to him, and gave such decisive proofs of capacity, that he immediately admitted him among his pupils. With unrelaxed assiduity he added to his acquirements, and he was upon the point of leaving the school and of entering with distinction into the Corps of Engineers of Bridges and Highways, when a new project of M. Trudaine's called him to another branch of service.

M. Trudaine, a distinguished member of this Academy, and one of those who have contributed much to spread enlightened principles of administration in France, satisfied with the impulse which he had given to the act of facilitating conveyance by founding the School of Bridges and Highways, thought that a similar procedure might operate beneficially upon a much more neglected part of administration, that of Mines.

Fortunately for France, her mineral riches will always remain the least part of those with which nature has favoured her. Her vast and fertile fields, her rich pasture grounds, her vineyards so remarkable for the variety and excellence of their productions, are an ample equivalent for the rareness of those metallic veins which are almost always indicated by the aridity and barrenness of the lands they traverse. But since we have some such lands too, it might be important to examine whether in all this sterility were uncompensated, or at least whether every thing had been done to determine this question.

Now, a brief examination of the preceding acts of the government, will presently shew that the mines, when they were not sacrificed to the cupidity of men of influence, had been given up to the empiricism of ignorant adventurers. The languid state in which they remained, was therefore by no means either necessary or irremediable; but to restore them to life, the first step to be taken was evidently to instruct those who were to work them. M. de Seychelles, then minister of finances, was fully capable of appreciating such enlightened views when proposed, and readily obtained for them the royal sanction.

To teach the art of mining, however, it was necessary to have instructors, and this country did not furnish so much as a single individual qualified, in a practical point of view, to undertake the office.

In fact, this art, which received its birth in Germany during the middle ages, had remained almost confined to working people. Scarcely had even a few treatises on Metallurgy and Assaying, founded on a rude system of chemistry, begun to be spread in France in the form of imperfect translations. It was only on the spot itself, from the mouth of these workmen, and in the view of their labours, that notions could be acquired regarding the rock formations which contained the mines, the laws of their situation, the best means of mining them, tracing them, and purifying their productions.

But if the workmen alone possessed all these secrets, it was necessary that those who were to wrest them from them should be more than mere workmen; enlightened minds could alone collect into a system that mass of scattered facts, the aggregate of which those who knew them were very far from being able to apprehend, or even to form a conception of their relations.

It was therefore resolved to take into the school of Bridges and Highways, some young persons already versed in mechanics and physics, and for the purpose of their being educated in the art of mining, to send them into the districts where the greatest progress had been made in that art, namely the Hartz in Saxony, Austria, and Hungary.

M. Trudaine's choice, as directed by M. Peyronnet, fell on M. Jars and on M. Duhamel, whose history we are relating.

As a preparation for their journey, they were sent to inspect the most important mines which France then possessed. From 1754 to 1756, they visited those of the Ardennes, of the Vosges, and of the Pyrenees; and, in 1757, they set out for Germany.

The diligence with which they applied to their researches, may be judged of by the collection published under the title *Voyages Metallurgiques*, which bears the name of M. Jars, but which is in a great measure the result of their united labours. All the memoirs regarding the forges of Austria, Styria, and Carinthia, and those of Bohemia and Saxony, are the work of the two young authors, and several of these memoirs were composed by M. Duhamel alone.

It would be unjust to estimate this work according to the present state of our knowledge. In the period of more than 60 years which has elapsed since it was published, the theory of all the sciences which treat of minerals has undergone two or three revolutions; and it must be remembered, that, at the time we allude to, the masters whom our young inquirers could consult were not theoretical men. The ideas which the directors and proprietors of mines then possessed, were scarcely more elevated than those of the workmen whom they employed. Every thing seemed mysterious in the purely empirical results on which their procedures were founded. The birth and maturity of metals were believed in; nature, it was said, required to be aided in bringing them to perfection. Mercury, sulphur, and salt, variously modified, formed their elements. In a word, metallurgy spoke almost entirely the language of alchymy.

Geology was still farther from having attained a scientific form. As yet, Lehman had scarcely distinguished with precision the secondary from the primitive mountains. The numerous circumstances relating to the superposition of minerals were not even imagined. Desaussure had not travelled, Deluc had not written, nor had Werner yet, by the power of his superior genius, in some measure reduced to order the mineral world.

It is a reflection which we are frequently obliged to make, when we have to retrace the history of our fellow-members whose career has been long;—the ideas and the language adopted in the sciences during their youth again occur to us, and we feel as if we were engaged with some nation of antiquity. Half a century has sufficed to metamorphose all; and probably, in the same period of time we also shall have become ancient to the generation that will succeed us. These considerations teach us never to forget the respectful gratitude which we owe to our predecessors, and never, without examination, to reject the new ideas which an ardent youth conceives, and which, if they are just, will prevail in spite of all the efforts which the present age may make to repress them.

This much is certain; the facts which MM. Jars and Duhamel collected are very numerous; that at that period they were almost entirely new to France; and the perspicuity and arrangement of their descriptions rendered them intelligible to all who might give them a perusal. The work in which they are embodied contributed essentially to that improvement in the art of mining, the fabrication of iron, steel, and tinned iron, and the digging for coal, which has of late years taken place in France. Their work also led to the increase of establishments devoted to the preparation and manufacture of these productions of the mineral kingdom.

It was not less honourable to the authors, that there prevailed a constant friendship between them both during their long researches, and when they were engaged in giving them to the public. Their connexion exposed them to become jealous rivals, but their character preserved them from that evil. Even abroad, their conduct was uniformly regular and respectable. They gained the friendship of several of the distinguished men whom they visited, and more than once proposals were made to them to accept of situations from the princes through whose countries they passed.

M. Duhamel especially, whose modesty formed a striking contrast to the generality of travellers from his own country, was held in very great esteem. The Austrian Government wished to attach him to their service, but he was called home, both by the official situation which had been promised him, and by another desire still dearer to his heart. Since his flight from the attorney, he had not seen his father, and the idea of having left traces of displeasure in the mind of the good old man weighed heavily on him. He hastened to implore his pardon. But it was not the prodigal child returning, miserable and humiliated, to his paternal mansion: it was a man of education, respectable for his conduct, and who had probably opened a surer path to fortune than that which he had been desired to follow. It will easily be conceived that the father's anger was appeased beforehand.

M. Duhamel the son, therefore, now expected to be installed in the functions for which he had been prepared by so long a trial. He went in haste to Paris, and made inquiries respecting the accomplishment of the preparations that had been announced. But a total change had taken place in the administration. A most unfortunate war had exhausted the finances. M. de Seychelles, the enlightened minister who had despatched the young people on their journey, had no longer the direction of affairs. Three other ministers had succeeded him in the short space of two years, without contributing any thing to public credit or prosperity, and M. Silhouette, the one who was then in office, had been more unfortunate than all the rest. An eternal ridicule has been attached to his name from the paltry dark likenesses at that time in vogue *, and which afford in some measure an emblem of his operations. It was not either to him or to almost any of those who succeeded him, each for a few months, still less to the Abbé Terray, of formidable memory, who governed the finances until the death of Louis XV., that any thing could be proposed with a view to future prosperity.

M. Trudaine, therefore, gave up his intentions for the present, and M. Duhamel remained without employment. He did not murmur, however, nor did he endeavour to obtain by solicitations what had been refused to his labours. As during all the rest of his life, he remained quiet, and sought for resources in himself. His leisure was occupied, and his existence supported by giving advice to mining companies. He even wrought for individuals, and, in 1764, he entered into the service of a rich proprietor as director of a great foundery, to which were joined several forges.

* Black profiles are termed silhouettes.

In this establishment it was quickly seen to what extent knowledge may contribute to the acquisition of wealth. In a few months the expense was diminished, and the produce doubled. An entirely new art was also introduced. From the year 1767, steel was manufactured of such excellent quality that it was bought up by certain Englishmen to be sold again as English steel, so much did they dread the loss of a reputation which they then exclusively possessed, and more than 300,000 hundred weights of it were annually manufactured.

Many years after this period the manufacture was pretended to have been imported into France, and a large reward was demanded for it. M. Duhamel acted with more disinterestedness. In 1777, he published his mode of procedure. On this occasion he added, as he always did, modesty to disinterestedness, and did not even take the trouble of claiming his right to priority that would have secured him wealth and independence.

A less dependent situation might have given a more extensive influence to his talents, and he conceived a plan that would have secured his wealth and independence. He formed a scheme of establishing founderies and forges in the barren grounds which it would have been easy to supply with fuel by means of the pines so abundant, and at that time so useless, in that sandy country. The articles of agreement were made out, the success of the undertaking did not seem doubtful, but it was necessary to leave the establishment over which he presided; and it seemed that a proprietor whom he had so effectually aided in becoming rich, could not withhold his consent to grant that freedom which in its turn might aid the fortune of the man who had served him so well.

It was quite the contrary, however. Duhamel's master, who was of a violent character, and was at this period in the highest credit, so far abused his power as to cause him to be apprehended by soldiers, and guarded in sight of his establishment. Scarcely would one of the great vassals of the crown have, at the height of the feudal system, attempted such violence. It proved at least the value that was attached to the services of M. Duhamel, and brought to mind those times when the alchemists were imprisoned, in the hope of forcing them to make gold.

Fortunately we were no longer in the 12th century; the King, to whom M. Duhamel's friends were obliged to make direct application, gave him all justice, and the circumstance having recalled him to the remembrance of the minister, contributed in the end to his withdrawing himself from the precarious situation to which he had been reduced.

In 1775, he was named commissary of the council for the inspection of forges and furnaces, which opened up anew the path to employment. However, he always regretted that this event broke up his plans with regard to the barren grounds, so firmly persuaded was he that they would not only be a new source of public prosperity, but also a certain basis to his own private fortune.

While he was connected with his great foundery, he had begun to make known his own discoveries and observations. In 1772, he made a journey to the Pyrenees, and shewed the advantages of the Catalonian method of manufacturing iron, and the possibility of applying it to the mines of the interior of the kingdom. It is well known that this method consists in making the ore pass immediately into a state of semi-fluidity, in a crucible, where it is preserved from the contact of air, and in submitting it immediately after to the action of the hammer. In this manner the great outlay required for the construction of furnaces is saved, much fuel is economised, and less is lost by combustion; the iron is separated and refined in the same crucible, and by a single operation. To prove that the rock ores of the Pyrenees were not the only kinds that might be thus treated, he had ores transported from the Angoumois and reduced at the Pyrenees. The operation succeeded perfectly.

Once free from all engagements with individuals, he set no bounds to his zeal, and his writings and experiments became more numerous. In 1775, he visited the mines of Huelgoat in Lower Bretagne, and discovered to the great benefit of the proprietors, that a substance of an earthy appearance, which they rejected as useless, was very rich in lead and silver. In 1777, he improved the forges in the same country, as well as the founderies of carron and iron balls at Lanoue, and published, as we have already mentioned, his secret with respect to the cementation of steel.

In 1779, he projected great improvements in the refining of silver, that is to say in the art of separating that metal from copper by means of lead. In 1783, he invented an instrument calculated fcr following better the direction of veins, and for determining the points at which they cross. In 1784 especially, the period of a great competition for a place in the Academy, he presented still more numerous memoirs than formerly. He furnished a means of extracting metal from the poorest galenas; taught how to treat without loss the ores rich in iron, by adding to them in suitable proportions earths calculated to produce a sufficient laitier, and thus prevent their combustion; shewed that most of the scoriæ of lead may still be turned to account; and pointed out the surest means of extracting gold and silver from goldsmith's ashes.

These last works procured him successively in the Academy the places of correspondent and associate, and at length obtained for him from the government the recompense so long promised to his first efforts.

The minister of Louis XVI. resumed the old projects of M. Trudaine. In 1781, M. Necker laid the first foundation of their realization, and, in 1783, M. de Calonne completed it. A school of mines was established at Paris, and after more than twenty years expectation, M. Duhamel was nominated to the chair of mining and metallurgy.

Undertaking such an office was devoting himself somewhat late to an occupation for which he was designed from his youth, and which should have been commenced with the active vigour of that age. Not only was it difficult for M. Duhamel to acquire all of a sudden the elocution which could alone fix the attention of his pupils; he had also to learn in detail the theories whose progress the exercise of art, and a life passed in forges and manufactories had not permitted him to follow, and to enter anew upon the meditations necessary for arranging them so as that they might be brought forward in a manner worthy of his office. He had to inform himself in short of all that science and time had recently added to the art. His devotion to his duties, and his love to his pupils, supplied all; from the beginning he shewed himself worthy of his situation, and during the thirty years he filled it, the affection and gratitude of those whom he taught continually rewarded his labours. The gratitude of many others also was due to him, could he have reclaimed it from all those whom he has enriched.

In fact, if it be desired to know what effect a well arranged institution, however inconsiderable it may be, what a public professorship, for example, may produce in a great kingdom, let it be considered what our mines then were, and what they have since become. Our workings of iron and coal are quadrupled; the iron mines which have been opened near the Loire, in the coal district, and in the midst of fuel, will produce metal at the same price as in England. Antimony and manganese, which we formerly imported, we now export largely. Chrome, which was discovered by one of our chemists, is also now the very useful production of one of our mines. Already very fine tin has been extracted from the mines of the coast of Bretagne. Alum and vitriol, formerly unknown in France, are collected there in abundance. An immense deposit of rock-salt has lately been discovered in Lorraine, and there is every reason to believe that these operations will not stop there. It is not undoubtedly to a single individual, nor to the erection of a single chair, that all this good can be attributed; but it is not the less true, that this man and this chair gave the first impulse.

It was for his pupils that M. Duhamel composed his principal work, of which a volume appeared in 1787, under the title of *Geometrie souterraine.*

It is well known that the metals, and especially the more precious metals, have not been distributed by nature in homogeneous and extended masses. Dispersed in small parcels among rocks, it is only by great labour that man has been able to become possessed of them. Nor have they anywhere been scattered at random. Their position, like all the other relations of natural objects to each other, is subjected to laws. It might be said that the oldest mountains have been broken or split to afford them asylums. Those immense fissures which traverse rocks in all directions, look as if they had been subsequently filled with the foreign materials at the bases of the mountain, and it is in the intervals of these foreign rocks, in these veins, that the precious molecules, often of very varied composition, are deposited. From them the successive discoveries of chemistry have enabled us to extract the metals in their pure state.

The art of the miner consists in discovering principal veins, in following them, in finding them again when they are interrupted, in allowing none of the accessory veins which may intersect them to escape; lastly, in raising all the parts that may contain metal, and in raising none else. He must therefore know the general laws of the distribution of veins, of their inflections and intersections; and when he has wrought out a part, when he has perforated the mountain in every direction in which veins have presented themselves to him; when he has scooped out a second time this labyrinth, which seems to have existed since the original disruption of the rocks, and before the substances which fill up the fissures were deposited; he must be able at all times to find his way through those gloomy recesses, he must even retain an accurate knowledge of the galleries, of the veins which he has abandoned, that he may not be annoyed by the waters, on coming imprudently upon them again by a different route.

Such is the object of subterranean geometry; it finds out the direction of the veins toward the cardinal points, and their inclination to the horizon; it fixes the three dimensions of the works; it follows them, and verifies their progress by clear and distinct images. Its means are such as they might be in those narrow cavities, where the view extends only a few feet, and where the light of day does not penetrate. Some lamps, a compass, and an instrument to measure the inclination, are all that can be used. It cannot, like common geodesy, either connect its operations with those of astronomy, or establish great triangles, to rectify its small errors. It therefore requires particular methods, which supply by their accuracy of detail those grand means of rectification; and these methods must be such as men of the class who pass their melancholy lives in those depths, may comprehend and execute with sufficient accuracy.

These operations are what M. Duhamel teaches in his book.

It is not a work of an elevated order of geometry, nor one that had the pretension of offering new mathematical truths: it is a purely practical treatise, a sort of surveying of a particular kind, but which the art of mining could want, and which every miner would have been obliged to make out for himself, had not the author spared him the trouble. This work is at the present day the manual of all who practise the art of mining in France; and as if the light of improved science ought to reflect toward the focus from which it had issued, it has been translated into German, and is very generally diffused among the miners of that country.

In the subsequent part of his work, M. Duhamel intended to treat of the other processes of the art, of the various modes of digging, incasing, walling, ventilating, and drying mines, of transporting the ore, picking, washing, stamping, melting, and refining it. The police of mines, their administration, the questions of law which refer to them, and the regulations to which they are subjected in different countries, were equally to be explained. But the events which involved the country in confusion a short time after the publication of his first volume, arrested the progress of the work, and we can form no idea of it excepting from the fragments which he has inserted in the Encyclopedie Methodique.

During these events, M. Duhamel himself was much distressed; but he acted as on all other occsions, he took precautions without complaining. At the first appearance of danger, he purchased some lands in America, and formed the resolution of carrying his talents to that country.

When on the point of embarking, he still granted some moments to the tears of his family: but in the few days which this delay occupied, the men who menaced every kind of merit were thrust down, and immediately the proposals of the government, which had been restored to some degree of moderation, fixed him anew in his country. After this period, he discharged the duties of professor and inspector-general of mines, and in the latter quality performed important missions, always with zeal, and always without ostentation. At length his age, and loss of strength, forced him in 1811 to retire. He was then 81 years old. The remaining part of his life was passed in calm retirement among a beloved family. The pains of the gout alone sometimes interrupted his tranquillity, and caused him the greatest of his disappointments, by preventing him from going regularly, as he had been accustomed, to hear his fellow-members at the Academy, for there he was as constant as he was silent. In his family he was as modest and mild as in the world.

At length he slept the sleep of the just, on the 19th February 1816, aged somewhat less than 86 years. A son, one of his most distinguished pupils, and inspector-general of the mines, revives his name in the career on which he first entered, and in which this son has already made not less remarkable progress than his father.

Observations in Answer to a Memoir by Messrs Sedgwick and Murchison on the Austrian Alps *. By Ami Boué, M. D. F. G. S. M. W. S. &c. &c. Communicated by the Author.

In the memoir of the two active members of the Geological Society of London, we were pleased to observe, that they had described and classified the various alpine deposites nearly in the order which we pointed out in our papers in the Edinburgh New Philosophical Journal for 1830, and in the Zeitschrift für Mineralogie von Leonhard, for 1829, and in the Journal de Geologie, Nos. I. & II. for 1830. Nevertheless, they have omitted some parts of the geological history of the Alps; or, at least, they hardly notice some of the prominent subdivisions of these formations, which certainly would not have escaped them had they allowed themselves sufficient time to take a more extensive view of that immense chain. As we are of opinion that the structure of the calcareous arenaceous chain of the Northern Alps presents peculiarities unknown on the southern side of the Alps, we could have wished that the authors in question had separated entirely the descriptions of each of these chains, because the intermixture of local details, sometimes from the one side, sometimes from the other side, are apt to deceive the reader, and induce him to believe that if a complete identity does

* The memoir appeared in the Annals of Philosophy for August 1830.

not exist, yet that there reigns a great similarity between the succession of the southern and northern alpine deposites. It has been long known, that, in Carinthia, especially near to Bleiberg, true transition rocks, even with their characteristic fossil shells, make their appearance. Our authors have added new and interesting details to those already known, in regard to this isolated occurrence among the Alps, and excite the wish that these ancient rocks may be farther traced, with the view of ascertaining whether or not they do not actually extend under the secondary rocks, in the direction of Idria. Now, as these rocks are entirely unknown along the whole of the northern alpine chain, from the Mediterranean Sea to the Carpathians, and as they do not occur in the Italian Alps, it would have been better to have presented this fact as an *isolated accident*, rather than endeavour to join these rocks with other calcareous and arenaceous rocks, without, or nearly without, organic remains, which some may be disposed to call transition, while others will refer them to the secondary class. Besides, if these crystalline masses, containing encrinal beds, described as occurring on the northern side, are truly transition, certainly their characters differ from those of the rocks of Carinthia, containing shells. On the other hand, we see the term *greywacke* applied to rocks on the northern side of the Alps, which make a transition from the micaceous or chloritose quartzose rocks, to others with a still more arenaceous character. We confess that these last mentioned conglomerated masses cannot be compared with, or referred to, the greywacke of the Hartz or the south of Scotland, but to us appear mere varieties of quartzose talcose rocks, deposites also well known in Scotland, which are, in our opinion, less affected and altered by igneous agents than the other primary, but formerly arenaceous rocks.

After these general observations on our authors' mode of treating the subject, we shall now take the liberty of examining the divisions which they propose. They distinguish, in the Alps, 1. *With all geologists, a central primary axis.* 2. *Crystalline rocks, with limestone beds, containing few organic remains, the system graduating into rocks agreeing with the ordinary transition type.* 3. *Red marl, sandstone, gypsum, &c. containing, in parts of their range, large subordinate masses of* *magnesian limestone.* 4. *Older alpine limestone.* 5. *Alpine limestone, with subordinate saliferous deposites.* 6. *Younger alpine limestone.* 7. *Tertiary formations.*

In regard to the central primary axis, we have but one remark to make, viz. that its termination is not distinctly given by our authors. The primary Alps, that appear to sink out of sight between Wien-Neustadt and Oedenburg, in Hungary, actually continue under the tertiary soil, and the valley of the Danube, and crop out again in the Neitra Comitat, to the east and west of that town. From this point, they extend to the NW. and NE. of Neusohl; and, lastly, they unite with the chain of Prassiva, Kralova, Hola, &c. The granitic group north of Presburg, as that of the Tatra, are only isolated portions of this chain. The central alpine chain would thus terminate geographically near to Vienna, but geologically in Northern Hungary. It is separated from the Carpathian primary chain, either because one part may not have been elevated to the same height as the rest, or because a partial sinking down has buried that portion. On the other hand, the primary chains of the Marmarosh and Transylvania, are evidently not in the same direction as the similar Alpine chain, and owe their origin to upheavings that have taken place in totally different lines of direction.

This is the opportunity to defend myself against a reproach of Messrs Murchison and Sedgwick. They accuse me *of pushing the spirit of generalization too far, of bringing under comparison formations widely separated from each other in the Alpine and Carpathian chains, sometimes by the help of mineralogical characters, and almost unassisted by a single organic remain.* If I am not mistaken, we might retort, and with more justice, on these gentlemen, when we find them intermingling the geology of Carinthia and Salzburg; but our defence will not rest on such criticisms. We have already proved, that the primary Alpine chains do continue in the northern Carpathians; and hence it is quite natural to expect in these last named mountains also, the continuation of the Alpine calcareous chain. This last fact is generally acknowledged; and I doubt not if these gentlemen had visited the Carpathians, they would have been the first to assent to it. It is to be understood that we do not mean to say that small calcareous deposites are placed along the primary Carpathian chain; for this is by no means the fact; but we repeat it, that, as in the Alps, from Vienna and Presburg, to the east of the Tatra, there is an uninterrupted calcareous band, which is often separated from the primary hills by a system of reddish arenaceous rocks. Besides, this alpine limestone is not much covered by more recent calcareous deposites, nor has it been so much thrown up, as to shew, as in the Alps, its whole body, and to allow us to see, in this calcareous chain, also the subordinate arenaceous beds or masses.

Our adversaries seem to imagine, not only that all our opinions in regard to the Carpathians are more fanciful than correct, but they also appear to insinuate, that we may have mistaken for alpine limestone some other calcareous deposite, which we could only have examined in a few spots, and that we afterwards united the whole according to our fancy. Happily, however, our map of the north-east part of Hungary, presented last April to the Geological Society of London, affords proofs of our local observations, united with those of Messrs Lill and Beudant, and which can at any time be verified. The calcareous alpine zone, which is coloured on the map, exists really in nature, and extends uninterruptedly from Vienna to Tatra. Every one will be able, on inspecting a good map, to see that the numerous localities where we studied the formation, and which we shall enumerate, were sufficient to allow us, even without the aid of organic remains, to decide that alpine limestone exists equally in Tatra as in the Alps. If it is ever allowable to make use of the witticism of Mohs, viz. that, as we cannot determine the species or genus of a tree from the birds that sit on it, consequently fossils cannot shew the age of a deposite, which must be determined by position and mineral contents, it is in this case. Indeed, if there be a continuation of the limestone ridges of the Alps and that of the Tatra, what necessity is there for taking into consideration the fossil organic remains? even if Trilobites occur in the Tatra alpine limestone, and Bacculites in that of Vienna, if both rocks form one single continuous mass, if they have the same position, they, in our opinion, are of the same age. Now, the Vienna or Baden alpine limestone reappears on the eastern side of the tertiary plain of that city, viz. at the distance of six or eight miles, at Wimpassing, afterwards between Teusch-Altenberg, Edelsthal, and Hainburg, from where it crosses the Danube to Theben, and, lying along the granitic ridge, it is found again at Ballenstein, at Borostyanko, at Pernek, at Breitenbrunn, at Blasenstein, Elesko, and to the east of Hradystie. From that village, and from Nadas, it extends to Csejta and Neustadt, upon the borders of the Wag near Bohuslariez, around Beczko and Trentschin, at Orecho, Sztrezezenitz, and between Hraboo-ka and Pucho. It forms the highest hills between the valleys of the Wag and the Nyitra, and is covered partly by secondary and tertiary rocks, a fact well known from the observations of Beudant, and confirmed by those of Lill. After having followed this formation, step by step, we had still an opportunity of studying it more to the north at Preeven, Illova, Warin, Bela, and Tyrhova. We saw it also extending behind Kubin, Chlebna, and Habowka; and a branch terminates on the northern side of the Tatra, from the west of Koscielisko to Zifjar; in the mean time another unites itself with the limestone south of the Tatra, and of the superior valley of the Wag, and extends to Newsohl, where we saw it on a former tour, and where others have described it.

It is true that, in this extensive calcareous chain, we observed fossil organic remains only between Warin and Tishova, around the Tatra, and in the country of Neusohl; but the same is the case with the Austrian Alps; and the magnesian rocks, full of small rents, seem far less favourable to the preservation of petrifactions than the complete dolomites. On the other hand, these fossils correspond with those of the limestone of the Alps, being belemnites, certain ammonites, certain smooth or folded terebratulites, encrinites, and zoophytes. In this way we have the identity and continuance of the same formation with the same fossils, and that from Vienna to the Tatra. Now, we ask (Mr Lill and I), are not we entitled to compare some sections of the Carpathian limestone ridge with others taken among the calcareous alpine chain, and to use in this way Carpathian localities, or sections where the strata have been but slightly deranged, to clear up in the Alps the nature of tracts, where great catastrophes or upheavings have disturbed and confused the true series of deposites? The answer to our question cannot be doubtful. If our adversaries, ignorant of the Carpathians, refuse to adopt our opinion, we beg them first to visit the country in question, for, without a knowledge of the country from examination, if they continue to deny what is obvious to us and others, they must not be astonished if we retort against their conviction and our own also, that the magnesian limestone, and the red marl of Durham, is not the same deposite as that which receives the same names in Nottinghamshire and Somersetshire. In both cases the reasoning would be absurd.

We rejoice, on the other hand, to agree fully with our authors respecting their mode of considering the *arenaceous reddish* system below the alpine limestone. It is well known that we, and also Professor Buckland and these gentlemen, compared it with the red marl, and even with the keuper, and that we endeavoured to find out in the thick beds of limestone, which are sometimes ferriferous, in the gypsum and the *rauchwacke*, some representations of the ancient secondary formations which are so well exposed in the southern Alps, and so well characterised from the Lago Majore to the Cadore. There is a great difference in the composition of the Alps on opposite sides. Upon the one side, the secondary formations, nearly unaltered, support the colossus of Jura limestone and chalk; while, on the other, the latter formations, with many peculiarities, and often with apparently strange fossils for such deposites, rest upon a series of aggregates, almost unknown elsewhere in Europe, and which are connected with the primary system. That union of limestone, containing immense masses of sparry iron-ore, with arenaceous talco-quartzose slates, is a Gordian knot, which can only be cut by our theory of igneous subterranean alterations.

In regard to the *inferior alpine limestone*, these gentlemen have been very fortunate in discovering in Carinthia the *Gryphæa incurva* in the dolomite of Bleiberg, thus rendering it a lias limestone. Notwithstanding the singularity of this fact, and that not more than two or three casts of the shells were found, we admit it. As this characteristic fossil of the lias is not mentioned by them as occurring on the opposite side of the Alps, we question if they are right in admitting the lias in the Salzburg Alps. If this deposite exists in the Alps of Dauphiny and Savoy, and even perhaps of Western Switzerland, the dark limestone so classified terminates in the Voralberg, and from thence to Tatra we observed nothing like it. Further, we find only predominating varieties of light coloured alpine limestone, which also exist in the Western Alps, or the magnesian limestones and the dolomites. Here and there at Werfen, between Abtenau and Radstadt, the undermost alpine limestone hides some small masses of dark coloured limestone, or of greyish magnesian limestone, which also exist as subordinate beds in the arenaceous red-coloured system; but it is by no means certain that these masses represent the lias.

On the other hand, we, as has been done by our authors, compared the whole alpine limestone with the oolite series, and even with the uppermost members of the series, and its saliferous subordinate masses appeared to be nothing more than *accidents* of the Jurassic subdivisions, not far from the Oxford and Kimmeridge clay. Their descriptions of the salt of Hall, Hallein, and Ischel are correct, and correspond with what has been very often published by others. Nevertheless, the peculiar cellular *rauchwacke*-like limestone near the salt of Hall escaped their notice; and the valley of Lavatsch behind these masses would have fully repaid, by its fossils, the trouble of a visit. At Hallein they appear not to have sufficiently distinguished the two or three great bodies of rock, where sandstone or limestone alternately predominate, and they have neglected to give the exact place of the orthoceratite limestone.

We observe with pleasure, in their article on the *newer alpine limestone*, that they place the saliferous arenaceous fucoidal deposite of Hallein under that kind of limestone which forms the Untersberg; this position, and the transition of these two rocks into each other, is the discovery of our excellent friend Mr Lill von Lilienbach. This same formation underlies, according to our authors, the hippurite limestone, covered by gypseous marls, nummulite rocks, sandstones and marls, with Gossau fossils. It is already known that they make the Gossau marls tertiary, and that the Untersberg would offer an isolated, or, if they choose, a second example of the transition from the chalk formation to the tertiary. This is the great point of controversy, which we shall consider in a subsequent part of this communication. On the other hand, they misplace the coal mines of the Alps of

Lower Austria, for they are not all in newer alpine limestone, as has been shewn long since in the writings of Stutz, Riepel, Constant Prevost, and our own papers, where it is made plain that these coal beds are in the inferior part of an arenaceous deposite, superior to that limestone, viz. in the Vienna sandstone, which they indeed mention shortly as a deposite, separating the newer alpine limestone from the tertiary rocks. Notwithstanding they acknowledge, in that sandstone, all the paleological characters of the secondary period, they do not inform us of the position which that sandstone occupies in relation to the hippurite and nummulite rocks; they rest satisfied in placing it above the newer alpine limestone. Besides, they annex to that sandstone, rocks belonging to the greensand, as, for example, the locality of Sonthhofen; but they do not venture to pronounce that greensand includes our Vienna sandstone. Still further, in speaking of the Kressenberg sandstone, which they believe to be tertiary, they describe Mount Kaschelstein, which is composed of Vienna sandstone, with ammonites and belemnites; and they separate carefully, by a *fault*, this deposite from that of the Kressenberg. Indeed, this is also our opinion; and they tacitly adopt it, by placing the Vienna sandstone between the superior alpine limestone and the greensand. Why, then, do they not mark the Kaschelstein in their section, Fig. 2?

The section on the *Tertiary formations* is that which most concerns me. They reproach me for not understanding their classification of Sonthhofen, a locality which they could not possibly place in the tertiary class, but in the secondary. We acknowledge our error here, but do not understand how they can separate the Kressenberg from it, which they describe as identical in a mineralogical point of view. The fossils alone remain their guide in this violent separation. Of 172 species of fossils of the Kressenberg, 42 have been considered tertiary by Count Munster, and no miner, they say, ever saw secondary fossils in this locality. This is their sole argument. We would first beg the Count to determine all the fossils of Sonthhofen, and then we would see if these crustacea (craw-fishes), belemnites, ammonites, are not associated with or covered by an aggregate of shells, partly of species still considered as tertiary. Until that be done, an important part for the solution of the problem by its fossils alone is wanting, for the presence of petrifactions is only accidental. As it is not necessary for the characterizing of every chalk deposite that it contain *Crania parisiensis*, may not the locality of Kressenberg have been unfit for the habitation of the animals whose remains are searched for in vain? Besides, why are the crustacea (craw-fishes) so abundant at Sonthhofen, and so scarce at Kressenberg? Why are the terebratulites more numerous in the first than in the second place? Why are more univalves in the latter than in the former, while the large oyster and the Echinidea seem equally distributed? Sonthhofen is acknowledged to be greensand, as also the Mount Fis, but turrelites occur only in Fis.

If the ferriferous deposite of the Kressenberg was isolated at a distance of 300 miles from Sonthhofen, and if such a deposite had been observed elsewhere in the tertiary series, the conclusion of our adversaries would be of some value. But this instance of pisiform iron-ore would be the only one known in tertiary formations; and further, this deposite is not isolated, but, on the contrary, it is connected with that of Sonthhofen by means of similar rocks which crop out here and there, on the foot of the Alps between Adeholzen and Anzig, behind Bergen, between Aschau and Rottau, especially near Branenberg, New-Baiern, and Heilbrunn. On the other hand, these gentlemen could easily have visited, from Salzburg, a similar deposite on the Haunsberg group north of that city; and if they had visited, as Lill and I did, the northern foot of Mount Trauenstein near Gmund in Austria, they would have seen there also the rocks and fossils of the Kressenberg, and those of Gossau, as they have erroneously marked in the section, Fig. 1. The nummulite iron-sandstone is there interposed between the Vienna sandstone and the alpine limestone; and the fossils of Gossau exist only on the southern side of Mount Trauenstein, in the small valley of the Eisenbach, and in another deposite.

Now, we ask, can a more evident connexion be desired? Is it not evident that the deposite extends along the foot of the Alps, from Mount Trauenstein to Sonthhofen, from whence it passes through the whole Voralberg to Switzerland, as these gentlemen also mention to be the case? We ask them, if they will not find it very difficult to classify all these localities between Sonthhofen and Kressenberg, and serving as connecting parts, and as yet unknown to them? They will themselves confess the small importance of the more isolated position of the Kressenberg compared with that of Sonthhofen, of which the hills are united to the alpine limestone chain; for this is only an *accident* resulting from a total (bouleversement) overturn which affected these mountains, of which some remained connected with the Alps, while others have been separated from them. At the Kressenberg, the inferior beds, which at Sonthhofen contain the inoceramus, the belemnites, &c., are buried under tertiary and alluvial rocks, or have been hidden by a falling down. Lastly, we ask our opponents what opinion they would entertain of our logical reasoning, if, on examining, at two distant points, their magnesian limestone which runs through England, and being unacquainted with the whole extent of its distribution, we should classify one point of it with the secondary limestone, and the other with the transition, in conformity with the fossils we had seen in each locality? Would they not say to us that the age of a deposite must be characterised by the whole of its fossils, and not by the shells of one or two localities; and notwithstanding the identity of many fossils of the magnesian limestone and transition limestone, they would remind us that, in the first, other fossils peculiar to this deposite may occur, which, however, may be wanting in different places, without changing the true state of things. I trust this example is quite in its place.

Our authors attack us also in regard to *our classification of the tertiary deposites of the basins of Bavaria, Austria, and Styria, and they reproach us for laying too much stress on mineralogical characters,* (p. 109). We thought we were as well aware as they of the insufficiency of this last argument. But are we right in saying that in the basins just mentioned, as in Switzerland, there are only tertiary subappennine deposites, or formations superior to the tertiary nummulite limestone of Paris. Our opponents contend that they have recognised, by means of the fossils in the basin of Gratz, rocks of the same age as the London clay. If they are of opinion that they have a sufficiency of fossil shells for establishing such an identity at such a distance, we would not be so foolish as to contest this conclusion, which, besides, is conformable with our own ideas, for we do not see any reason for considering the London clay as an equivalent of the whole mass of the Paris tertiary limestone; and, as we reject the plastic clay as a distinct formation, arranging it as subordinate to the limestone, we do not see the necessity of a plastic clay in England. No one in England would have thought of separating the plastic clay and the London clay, if that formation had not been proposed and established at Paris; now, however, as that opinion is admitted to be erroneous, it is plain that there is no longer any necessity for searching for it in England. In short, the London basin seems to us to be only a portion of that vast basin of Northern Europe, where the superior deposites predominate, and not at all an equivalent of the Parisian one.

At page 109, on the locality of Haring in the Tyrol, our authors reproach me with having overlooked the marine shells; if, however, they turn to my work on Germany (Geognostiches Gemälde Deutchlands mit rucksicht auf den benachbarten, Lañdern 1829), they will find, at page 403, that we discuss what genera of marine fossils are to be found there. Häring appears to have been a kind of lagune in a longitudinal valley, which, communicated by some rents with the Bavarian tertiary sea, but the rest of the valley of the Inn was formed by far later fissures, for it does not contain tertiary rocks. On the other hand, it is well known that Häring presents some dubious characters which have induced some observers to place it in the green sand, although still the most plausible arrangement is with the tertiary lignites.

In regard to the *Nagelfluh* (p. 109), they confess not to be completely acquainted with it; but *they lay much stress upon the opinion that it is a tertiary deposite.* It cannot be doubted that there are nagelfluh or calcareous conglomerates in the true molasse. Other similar beds occur also in the uppermost tertiary formation, as at Vienna; and even the alluvial soil contains great deposites of nagelfluh, as at Salzburg, and in the Austrian alpine valleys. But there is also another conglomerate, a very thick deposite, which borders some parts of the Alps, especially in Switzerland, which, according to every well-informed geologist, has very peculiar characters, viz. that it contains not only debris of all the different secondary alpine limestones and sandstones, but also rounded fragments of primary and secondary crystalline or slaty rocks, which are foreign to the alpine geology. No one but will at once see the high interest of such a composition; and he will find, without surprise, fragments of this rock in the more recent nagelfluhs. Now, these peculiar rocks appear as if dipping under the alpine limestone, while, on the contrary, as along the Lake of Zug and elsewhere, the molasse appears to dip under the first deposite; but no one has been able to confirm the truth of this double position, and nobody ever found in the ancient nagelfluhs any of the shelly beds of the tertiary molasse. For these reasons, we still remain persuaded that it is a secondary deposite, and that its peculiar position in regard to the neighbouring masses of rocks is only an *accident*, caused by the upheaving, which affected not only the calcareous chain, but also the horizontal tertiary beds. The same peculiar nagelfluh rocks have been found under the greensand of the Voralberg and the Allgau, and again north of Salzburg, and even to the south-east of that town. Lastly, in the middle of the Austrian Alps, the alpine limestone appeared to us to support here and there chalky deposites, at the base of which limestone were seen naglefluh rocks associated with molasse-like rocks. In this last case, as to the north of Salzburg, they contained rolled masses foreign to the mountains composing the Alps. In those places where these foreign boulders were wanting, the chalky deposites were so isolated amongst lofty limestone hills, or surrounded by them as in basin, a situation which sufficiently explains the absence of such boulders or transported rocks, which no force could have brought into such hollows. All these facts brought to our recollection the rocks in the vicinity of the Swiss nagelfluh, and we imagined that we saw there the same connexion of these problematical masses with greensand rocks, as to the south of the Rigi, at the foot of the Pilatus, at Thun, at Saarnen, at the Voirons, &c. We wait now for the dissent or assent of alpine geologists to this statement.

Lastly, We come to our controversy in regard to the *age of the Gossau deposite.* In their section (Fig. 1.) they have well expressed its unconformable and overlying position upon the alpine limestone, and in a deep and large cavity of that formation. We grant them that similar beds are to be found in some points at the foot of the northern alpine chain. On the other hand, we shall be careful not to compare, as they have done, the position of the Gossau rocks with that of the molasses in the longitudinal valleys of the eastern Alps, and conclude from this false view *that rocks of the same age can exist also in the Salzburg alpine valleys*, (112). Indeed, most of the valleys of Salzburg are transverse; that of Gossau is of this description; the longitudinal valleys of that country are occupied by lakes, but these do not, any more than the transverse, offer traces of tertiary rocks. These transverse valleys have been formed generally during a period posterior to the tertiary rocks, and the lakes have perhaps occupied more ancient cavities, without directly communicating with the tertiary sea covering the existing flat country. In the same manner, it is acknowledged that the longitudinal valleys of the eastern Alps are far more ancient rents than those which conduct the traveller through the alpine limestone chains. The comparison of our opponents seems so erroneous, and the case of Häring, again brought forward, appears so much of the same description, that we cannot help expressing our astonishment that sets of rocks, so different as those of Häring and Gossau, should be compared together. Lastly, If the valley of Gossau has been filled up by tertiary rocks deposited by an arm of the tertiary sea of the flat country, Why do these same beds not occur throughout the space between Gossau, Gmund, and Saltzburg, in all these great transversal and longitudinal valleys? Hence we cannot see the probability, with our adversaries, that tertiary deposites may have been formed in the valley under examination (112).

On the other hand, they remark, *that there is a great break between the chalk and the calcaire grossiere or tertiary inferior limestone* (182), and that a deposite somewhere fills up the interval, and connects the tertiary soil with the chalk. The hill of St Peter, at Maestricht, owing to its containing a mixture of secondary and tertiary fossils, is proposed as an example of this kind. First, after reproaching me with comparisons taken in distant countries, it seems that my critics expose themselves still more than I to this objection, for Maestricht is very far from Gossau, and that limestone bears but little resemblance to that of Gossau, in its position, nature, and fossils. Besides, the small number of similar petrifactions is of no consequence, because this *accident* can be explained by placing both deposites in the chalk, as well as by classifying both in the tertiary soil. But most conchologists and geologists still consider the bacculite limestone of Maestricht and of Valognes, which resembles that of the Danish Isles, as a part of the chalk formation.

After having considered the deposite of Maestricht, we return to the reasoning, apparently fair, *that the tertiary soil appears always to be separated from the chalk by a break.* Our adversaries forget that there are a good many similar cases in geology. Thus, in certain basins, the old alluvium (diluvium of some English geologists) occupies a higher level than the modern alluvium; the two deposites are not intermixed either by transition or alternation; because, probably, sudden ruptures, various catastrophes, have occasioned a sudden sinking of the level of the water during the alluvial period. Besides, how many formations, deposites, and even beds, are not placed in unconformable and overlying stratification, the one upon the other, in consequence of accidents occasioned by upheaving, slipping down, and total overturning, which have affected the inferior masses, before the deposite of the superior ones? The case of the chalk seems to us a very simple one, for we do not see the necessity of its being connected, at least in Europe, with the tertiary soil; at the same time, we do not deny that such may be the case in other parts of the world: allowing such a possibility, we do not see the necessity for a new and unknown formation to effect such an insensible transition. We agree with many eminent geologists in thinking that, in Europe, the termination of the chalk period was characterized by tremendous catastrophes; whole chains of mountains have been heaved up, immense lines of volcanic eruptions first made their appearance, and in consequence most dreadful and great ruptures took place, and whole continents were thrown up. In this way, the sea would leave dry a great part of the countries it formerly covered, and the deposites formed under its surface, or along the shores, would naturally occur in unconformable and overlying stratification, sometimes in gulfs surrounded by steep chalk-cliffs, sometimes in primary or secondary creeks. The immense changes that took place at that period are fully adequate to explain why whole classes of animals, as belemnites, &c. and even of vegetables, disappeared from Europe, and that other animals and plants took their origin, or sprang into existence from this new state of things.

In pursuing our examination of the reasoning of our adversaries, we were startled with the following remark,—" *that if the Eastern Alps have been elevated at so recent a period, there must be on their flanks a continuous succession of deposites between the new secondary, and the older tertiary periods*," (112). We really do not see the force or meaning of this observation, for we cannot see what an upheaving, may it even be alluvial, has to do with the existence of certain deposites, for very few formations, and especially the more recent ones, are generally distributed over the whole surface of the globe. The deposites wished for may, or may not, have existed along the Alps; but the fact is, that no one, excepting our authors, have found a trace of them.

We agree with our authors " *that the age of the Gossau beds must be determined by their relations, structures, and fossils, and that there is nothing in their relations and structure which proves them to be older than the chalk (including the greensand). Besides, we confess that the appearance of many, and even of the greater number of the Gossau fossils, is tertiary, from their state of preservation, the great preponderance of univalves over bivalves, and the incredible abundance of shells of certain genera, seldom found except in the newest formations*," (p. 112). But, on the other hand, we find ourselves brought back to the secondary class by the gryphites, catillus, inoceramus, neritina, trigonia, plicatula, the pecten quinquecostatus, &c. If, contrary to acknowledged geological principles, we neglect the difficulty occasioned by the presence of secondary chalk fossils, and attend only to the tertiary shells, shall we be right or wrong in maintaining that the deposite is newer than chalk? We do not believe that this mode of proceeding is allowed; and we are gratified to find our opinion agree with that of men well fitted for judging of such difficulties. First, if Mr Alexander Brongniart classifies, as do our opponents, the greensand of the Kressenberg in the tertiary class, it is because he has been shewn only the tertiary genera;

but when he finds at Gossau inoceramus, and all the other secondary genera, he does not hesitate to be of our opinion. If we consult geologists the most intimately connected with the recent secondary deposites in the Alps and in the Pyrenees, we find their opinion in conformity with ours. Thus, M. Beaumont agrees with us in regard to Gossau and Kressenberg, for he found, during his journeys through Eastern France, similar anomalies. M. Dufresnoy, at present occupied with the geological map of Southern France and the Pyrenees, is still more in our favour, for he acknowledged many fossils in our collection to be identical with those which he found in greensand. After a careful study of all the fossils from the chalk formation of the countries under examination, he concludes, that out of 240 species, 40 are species that, until now, were considered as tertiary, a case similar to that of Gossau. Still, not satisfied with the high testimonies in our favour of the opinion of Messrs Partsch, Kefferstein, Lill, and ourselves, we consulted chonchologists. M. Deshayes, who saw the collection of Messrs Sedgwick and Murchison, as well as mine, cannot admit their conclusion; and even dares not pronounce the perfect identity of any of the pretended tertiary species of Gossau with those species known in various tertiary basins in Europe. In London, Mr Sowerby seems to have been less cautious, for he named at least some species. M. de Roissy was also astonished with the ideas emitted by our adversaries. M. de France, assuredly the most learned man in this department of natural history at present alive, also did me the favour of examining my fossils from Gossau. His opinion also is against the view of Messrs Sedgwick and Murchison. This excellent man said to me, "I have collected fossils for a long time, and hence you would conceive that the species in my cabinet would increase; but this is not the case. On the contrary, the more individuals I receive, the more transitions of one species into another I observe; and, consequently, the number of species become less and less. Each locality appears to possess not so much its own species, as more frequently its own varieties of every where nearly the same species. This circumstance, too much neglected, makes the best works on fossils only applicable to certain localities. If, on the other hand, we could get together from all parts of the earth, all the series of fossils, we would see a great many species from one locality, identify themselves with those of others, because the connecting links would be present. In short, conchologists do not possess the means of fixing the specific characters, and sometimes not even those of the genera; this can only be done by the study of the animals, without which no one can trace a strict line of separation between the accidental and specific characters of the species of fossils or of shells."

But we must now return to the *petrifactions or fossils of Gossau.* The state of *preservation* of the fossils, as Brongniart well observes, is a character of no importance; for, according to this character, we could classify, in the tertiary class, certain fossils from the Lavatsch Alpine Valley in the Tyrol, from Raibel in Carinthia and even sometimes transition shells, or place in secondary formations some tertiary shells. The learned gentlemen admit that "*out of more than* 100 *different species, there are from* 30 *to* 40 *bivalves, and of those capable of being identified, nearly equal numbers are referable to the youngest secondary, and the oldest tertiary, formations. The univalves are much more numerous, especially in the quantity of each species, a fact seldom remarked in secondary deposites. Among upwards of* 50 *species,* 3 *only are found in the chalk or greensand, whilst* 7 *species are identified with known tertiary fossils; and several of the genera, such as Volvaria, Pleurotoma, and Voluta, are seldom, if ever, found in any deposite below the surface of the chalk.*" They admit, in this way, at Gossau, more than 50 new fossils, which geognostical classification they do not give us; besides, in their conclusions, they do not exclude any of the fossils from the recent secondary formations; but remain satisfied that, heretofore, certain fossils had not been found, or were very scarce, in those secondary formations, which have been well studied only in England, and in a few places in France. The greensand fossils have much greater affinity with tertiary fossils, than with those of older secondary rocks. They admit hippurites in the Gossau rocks, but we suspect that this fossil is only accidental, and is a rolled mass of hippurite limestone taken up and enclosed in the rock, forming the base of the deposite. On the other hand, they are not willing to believe that the *Gryphæa columba* may be found at Gossau, at least they do not speak of the fact adduced by us. If we alone were to support this *accident*, we would have a strong party to combat, and our assertion might be more than counterbalanced by their complete denial; but we have fortunately an arbiter in this case they cannot refuse, having formerly accepted his evidence. Count Munster wrote, March 1828, to Kefferstein, that he had observed among the Gossau fossils, young specimens of the *Gryphœa columba* of the greensand, and his letter was published in the Geological Gazette, page 99 of the 6th vol. part 2d, of the *Teutchland Geognostisch-Geologisch dargestellt.* published in 1829 by Kefferstein. In my collection, I have that fossil in the state described by Count Munster, and Mr Lill has it also. This is a case in which we may apply the judicious observations of De France, upon the variations which a species may undergo, or upon the different states in which a fossil may have been petrified in various localities. We trust that this explanation will dissipate every doubt regarding this point, and that my opponents will also be forced to place in the tertiary formation this fossil, so characteristic for the greensand, or they must change their opinion. Besides, M. de France recognised in my collection another small species of gryphite, which he has from other chalk localities.

Lastly, we come to the singular reproach made to us, that, in order to *determine the age of the Gossau deposite, we had recourse to the characters presented by similar patches found here and there in the Austrian Alps.* Our mode of proceeding, whatever our authors may say to the contrary, is strictly logical. It was only necessary to be certain that the localities we compared were geologically identical, on which point there remains not a shadow of doubt in the minds of those geologists acquainted with the country, viz. Messrs Partsch and Kefferstein. Unfortunately our authors visited only Gossau, but they are not from this circumstance to deny that similar deposites may not exist elsewhere. Indeed, such an assumption would be in opposition to their own theory, according to which, this formation should have been pretty generally distributed and divided into isolated masses by the upheaving of the Alps. If they had seen, as our excellent friends, Mess. Partsch and Kefferstein, and we also, the localities of Grünbach, Hieflau, Gams, Hinter Laussa, Launz, &c., they would not have written that "*we had no right to transport the reader over* 150 *miles of alpine limestone, and then to assert, that at Grünbach, Piesting, &c., the same deposite as that at Gossau contains belemnites and certain other secondary fossils.*"—(P. 111.)

When we find again at Grünbach, at Piesting, &c., the same rocks as at Gossau; when we see these rocks in a similar position; and when three geologists recognise in these beds a great many of the same fossils as at Gossau; does it not seem that we have a right to speak of that deposite when we are endeavouring to classify the problematic deposite of Gossau? and we ask if it be allowed to say, as those gentlemen do, *that such an argument is nothing better than a direct inversion of the rules of induction?* (p. 111.)

The hurry of writing is the only excuse we can offer for such an expression of opinion; for what would our critics say, if we, in their classification of the patches of greensand in the southern parts of England, would deprive them of the liberty of placing under one head all the fossils of the greensand of the Isle of Wight, Dorsetshire, Hampshire, and Kent? They would certainly consider me a strange logician. Besides, in the case of Grünbach, these gentlemen are the more to blame, as M. Keferstein had already, in 1828, in the 5th vol. p. 446, of his *Teutchsland Geognostisch-geologisch dargestellt.*, well described the locality of the Wand, and had well identified by means of the fossils the deposites of Grünbach and Gossau. If we find belemnites, litulites, anachites, &c., at Grünbach, it appears to us, after this long discussion, that we should mention the fact, and make use of it to establish more certainly that the Gossau rocks are not tertiary, but secondary. We do not see any thing extraordinary in the circumstance, that, in the same formation, some fossils may be awanting in one locality, but present in another, as is the case at Sonthhofen and the Kressenberg. The deposite of Gossau also offers similar and striking examples; thus, at Gossau, there is a pretty large and abundant ampullaria or natica, the place of which at Gams appears to be replaced by a pretty large species of tornatella, and at Wand both fossils occur in great abundance.

We have now finished our examination of the memoir of Messrs

Sedgwick and Murchison, and we hope it has been shewn that no tertiary deposites (at least as they are understood at present) exist in the northern Austrian Alps, and that the tertiary rocks of the Austrian flat land do not ascend into the transverse valleys of the Alps. Besides, we think we have shewn that the Jura limestone, composing the alpine calcareous chain, is covered in different places, as in the French and Swiss Jura and in the German Alps, by isolated patches of rocks belonging to the greensand and the chalk. If these last deposites do exist on the borders of the Alps, we positively deny that there is a transition from that formation to the tertiary one, and we defy any one to prove this, if we admit the total absence of tertiary rocks in the middle of the Alps. We might conclude here, and await the answer of our opponents; but we feel it right, as some observers, not aware of the extent of our investigations, might suppose that our statements were founded on few facts, to state the extent of our travels, which were continued for several years in the Alps. Messrs Sedgwick and Murchison also felt it necessary to enumerate on how many excursions and sections their ideas were based.

Since 1821, we have visited in our various journeys, first the whole of the northern calcareous and primary chains of the Alps from Feldkirch in the Voralberg to Eisenerz and Somering in Styria; the country south of the Lofer in the Tyrol alone remained unexplored by us. On the other hand, we made a journey for the sole purpose of following step by step the northern foot of the calcareous secondary chain, in order to study thoroughly the range of the secondary sandstone, and its contact with the alpine limestone and the molasse. That journey was performed without interruption from Sonthhofen in Bavaria to Vienna in Austria, and during it we entered in succession a great number of the valleys. Since that time, we have added to this survey a fortnight's stay at two different times in the Allgau, an excursion in the Voralberg, and we have been so circumstanced as to continue similar observations in various places in Savoy and Switzerland. In order to become well acquainted with the alpine structure, sections throughout the whole chain were necessary; and hence we made it our business to examine, at various times, nearly the whole of the passes that cross the range. Beginning on the west and proceeding to the east, we crossed the Alps successively in the valley of the Rhine, in the Voralberg, in the Allgau, along the Lech, between Fussen and Nassereit; between Seefeldt and Amergau; between Seefeldt and Benedictbeuren; along the Inn, to the southern Tyrol over the Brenner; partly to the south of the Chiemsee lake, in the valley of the Bavarian Traun, of the Saal, and the Achenbach; along the Salza from Salzburg to Werfen; from Salzburg to Liezen; from that place to St Gallen; from Steyer to Eisenerz; from Waidhofen to Eisenerz; from Gaming by Neuhaus, Palfau, and Gams, to Eisenerz; from Neuhaus to Mariazell; from St Polten to Seewiesen by Maviazell; from St Polten to Baden and Vienna; and from Vienna to Gratz and to Croatia, through the Matzegebirge. The collections of rocks made at all these and the following localities I have preserved, and will be delighted to explain them to geologists.

In the southern Alps, we have visited in the same way all the southern border of the calcareous alpine chain from Bergamo to Conegliano. We have ascended along the valleys of the Brenta, seen those of Fassa, of the Cordevole, of the Piave, of the Fella, and of the Drave. Lastly, we crossed the Leoben; we visited Bleiberg, Raibel, Laibach, Idria, the valley between Idria and Lack, Trieste, and Fiume. We went over the greatest part of Istria to its southern termination. We entered into Dalmatia, crossed the Capellen-Gebirge from Buccari to Carlstadt, and, after an excursion farther east, we followed the road from that town to Laibach. We may add, that, well informed of all the difficulties in classifying the Gossau deposite, we last year made a journey through the Austrian Alps, for the sole purpose of studying thoroughly all the well known localities where such rocks occur, and of establishing a reasonable classification, and describing each locality. After these journeys, continued during nine years, for the study of the alpine limestone chain in Germany, we thought that we might, assisted by our friends, attempt to lay before the geological public the conclusions explained in this paper and elsewhere. In what relates to the difference of our opinion from that of Messrs Sedgwick and Murchison, the public will now be able to judge; and, we trust, that they will ere long favour us with an answer, written with that calmness and spirit of concord which ought always to accompany scientific discussions.

On the Chemical Constitution of Brewsterite. By Arthur Connell, Esq. F. R. S. E. Communicated by the Author.

This mineral was first characterized, from its crystalline form, as a distinct species by Mr Brooke, who also gave it its present name *.

It would appear that, some years ago, a specimen of the mineral was sent by Dr Brewster to Berzelius, for the purpose of being analyzed; and that Berzelius wrote back in answer, that it had been already analyzed by Retzius, conformably to the formula $\frac{C}{N} S^3 + 4\, A\, S^3 + 8\, A\, q$, and called by him Prehnitiform Stilbite †. This formula, or the corresponding chemical one, has been retained by Berzelius ‡; and I am not aware that any other statement respecting the constitution of the mineral has been given to the public. The locality of the mineral analyzed by Retzius is not stated. The formula of Berzelius gives §,

Silica,	57·285
Alumina,	17·011
Soda, Lime,	7·764
Water,	17·872
	99·932

In a former notice on this subject ||, I shewed, from an examination of some pure crystals of Brewsterite from Strontian in Argyllshire, that it contained strontia and baryta, and no notable quantity of lime. I also shewed that it contained no alkali, and concluded that the formula of Berzelius did not apply to the mineral, at least when derived from the above locality, unless the formula and composition could be accommodated to one another by the aid of the doctrine of replacement.

It became a matter of some interest to establish by a regular

* Edin. Phil. Journal, vol. vi. p. 112.
† Edinb. Jour. of Science, vol. iv. p. 316.
‡ Die Anwendung des Löthrohrs, 2te Auf. S. 168.
§ This calculation is made by the atomic weights of Berzelius. All the subsequent calculations of formulæ are made by those of Dr Thomson.
|| Edinb. New Phil. Jour. No. 16. p. 355.

analysis that the strontia occurs in the mineral as a silicate, and in such quantity as to constitute an essential constituent; because that earth had not hitherto been found in nature, except as a sulphate, or carbonate *.

The specimen of Brewsterite which was the subject of the following researches, consisted of a kind of concretion of the mineral, partly in crystals, and partly in an amorphous state. Previous to analysis, it was submitted, in the condition of fragments, to the action of water, acidulated with muriatic acid, for the purpose of removing any soluble foreign matter.

25·15 grains of the mineral, in the state of fragments, lost, by ignition, in a platinum crucible, and charcoal fire, 3·16 grains, equivalent to 12·584 per cent.

48·34 grains, in impalpable powder, were fused over the spirit lamp, with about three times their weight of a mixture of 5 parts of carbonate of potassa and 4 parts of carbonate of soda, care being taken to employ carbonates free from any sulphate. The mass, after being softened by water, was dissolved in dilute muriatic acid, and the silica separated in the usual manner. The silica, after being ignited and weighed, was dissolved in boiling potash-ley, and left a little residue, which appeared to be undecomposed mineral, and was subtracted from the quantity under analysis.

The residual solution, separated from the silica, was precipitated by ammonia. From the precipitate thus obtained, a little silica and oxide of iron were separated by the agency of muriatic acid, and subsequently of caustic potash in excess. A quantity of alumina was then got, by supersaturating the alkaline solution with muriatic acid, and precipitating by carbonate of ammonia. The alumina was ignited, and weighed.

The liquid which had been precipitated by ammonia was concentrated by evaporation, and carbonate of ammonia was added to it whilst hot. A white precipitate fell, which, after being collected and washed, was dissolved in dilute nitric acid. The solution by evaporation gave a crystalline residue, showing

* Baryta, besides occurring in its usual natural states, and as a silicate in some varieties of harmotome, occurs apparently in combination with oxide of manganese in some of the ores of that metal, as has been shewn by Klaproth and Dr Turner.

chiefly small octahedrons, and mixed with some deliquescen matter.

The deliquescent matter was taken up by alcohol, which left the crystals undissolved. The alcoholic solution was decanted, and converted to a watery solution, to which oxalate of ammonia was added. A white precipitate fell, and the whole was evaporated to dryness. The dry mass was then ignited, a little solution of carbonate of ammonia added, and heat again applied. Some carbonate of lime was thus got, having a trace of iron.

The nitric crystals left by the alcohol were now ignited in a silver crucible, to drive off the acid. The caustic residue was dissolved in very dilute muriatic acid. The muriatic solution was evaporated to dryness, and the dry mass ignited, and weighed. Redissolved in water, a little residue was left, the weight of which was subtracted from the ignited mass. The solution by evaporation gave a mixture of long prismatic, and tabular crystals, having all the appearance of muriate of strontia and muriate of baryta. The former were taken up by hot alcohol, to which a few drops of muriatic acid were added. The latter were left undissolved; and after being separated from the alcoholic solution, and washed with alcohol, were ignited and weighed, and their weight subtracted from the joint weights of the ignited chlorides, by which means the amount of the chloride of strontium was determined. The amount of the chlorides gave by computation that of the strontia and baryta respectively. From the small quantity of matter left undissolved on the solution of the chlorides in water, after their joint ignition, a little silica, and also a little carbonate of strontia, were separated, which were both duly taken into account.

On recrystallizing the chlorides from watery solutions, the salts obtained had the crystalline form, and all the properties of muriate of strontia and muriate of baryta. The former gave to flame a fine red colour, and the latter a slight greenish tinge. The solution of both afforded white precipitates with sulphuric acid.

Another analysis of 47·37 grains of the mineral was executed in a manner not materially differing from the preceding process, the principal distinction being, that the proportions of the alkaline earths were determined on a separate quantity of the mineral of 25·62 grains, a portion of them from the original quantity having been accidentally lost.

The manner in which the analytic process was conducted afforded sufficient evidence that the alkaline earths did not exist in the mineral in combination with sulphuric acid. But to ascertain with still greater precision whether the mineral contained any traces of sulphates, a little of it, in powder, was fused with carbonated alkalis, the mass treated with hot water, the solution deprived of silica and alumina by carbonate of ammonia, and saturated with muriatic acid. No precipitate was then got with muriate of baryta.

On treating a similar solution, to which ammonia had been added, to take off the excess of muriatic acid, with muriate of lime, and keeping it for a few days in a close vessel, some precipitate which had formed seemed to be carbonate of lime, with traces perhaps of silica or alumina. There was thus no evidence of phosphoric or fluoric acids.

To ascertain whether the mineral contained any alkali, 33·11 grains in fine powder were strongly ignited with six times their weight of carbonate of baryta. The usual steps were taken to separate silica; and the earthy contents of the muriatic solution were thrown down by carbonate of ammonia, its action being aided by heat; the whole evaporated to dryness; the residue repeatedly redissolved; and new additions made of carbonate of ammonia. The muriate of ammonia was then driven off by heat. No trace of an alkaline chloride could be found.

The two analyses which have been mentioned corresponded perfectly with one another, in respect of the nature of the constituents of the mineral; and, although in the one, some loss, and in the other, some excess, was got *, yet they did not differ essentially in the proportions of the constituents in relation to one another. By taking a mean of the two analyses, the excess

* The excess was, I believe, owing to the circumstance, that, in heating the mineral, after being reduced to powder, and before weighing, with the view of expelling any hygrometric moisture, the heat was raised a little too high, by which means, some of the chemically combined water was expelled. The loss in the other analysis, was partly owing to the circumstance that separate portions of the mineral were used in the course of it.

and loss are nearly neutralized, and we obtain nearly the same proportions of the constituents in relation to one another, as is afforded by either of the actual results. The mean of the two analyses is as follows:—

Silica, ...	53·666	
Alumina, ...	17·492	
Strontia, ...	8·325	15·074
Baryta, ...	6·749	
Lime, ...	1·346	
Oxide of Iron, . . .	·292	
Water, ...	12·584	
	100·454	

When we endeavour to ascertain in what atomic proportions these constituents are combined, we find that the formula of Berzelius, in so far as respects the solid contents of the mineral, comes near its constitution, if we substitute strontia and baryta for lime and soda. The relative proportions of water, however, afford a considerable obstacle to their accommodation. In the above analysis, it will be observed that the proportions of the baryta and strontia to one another, approach the ratio of 1 atom of the former to 2 of the latter. For,

9·75 [atom baryta] : 13 [2 atoms strontia] : : 6·5 : 8·666.

—In one of my analyses, the proportions obtained bore almost exactly that ratio to one another.

If we substitute strontia and baryta for lime and soda in Berzelius' formula, we get

$$\frac{Sr}{B}\,S^3 + 4\,A\,S^3 + 8\,A\,q;$$

and if we multiply the whole by 3, we get

$$2\,Sr\,S^3 + B\,S^3 + 12\,A\,S^3 + 24\,A\,q.$$

If we calculate this latter formula, or the preceding one, taking $\frac{Sr}{B} = \frac{2\text{ at. Stron.} + \text{at. Bar.}}{3}$, we get

Silica, ...		53·973
Alumina, ...		16·192
Strontia, .	7·796	13·642
Baryta, .	5·846	
Water, ...		16·192
		99·999

Which comes near the preceding analysis, with the exception of the water. With respect to this constituent, I may observe, that, on igniting a portion of the mineral containing a larger proportion of crystals than the specimen analysed, I got 13·359 per cent.; so that, if nothing but crystals were analyzed, the proportion might be still greater, although it is not likely that it would be so great as shewn by Berzelius' formula. If we could suppose that the mineral analyzed by Retzius really differed from the Brewsterite from Strontian, only in lime and soda being replaced by strontia and baryta, this mineral would afford a good illustration of the doctrine of replacement.

According to the results of my own researches, however, the formula which best expresses the constitution of Brewsterite from Strontian, is

$$\frac{Sr}{B} S^2 + 4\,A\,S^3 + 6\,A\,q; \text{ which gives,}$$

Silica,	54·58
Alumina,	17·543
Strontia, Baryta,	14·717
Water,	13·16
	100·

Or, if we suppose the proportion of the strontia and baryta to be 2 atoms of the former to 1 of the latter, the constitution will then be, 2 atoms bisilicate of strontia + 1 atom bisilicate of baryta + 12 atoms tersilicate of alumina + 6 atoms of water.

The title of this mineral to be viewed as the first instance of strontia occurring as a silicate, seems to be established.

A Series of Barometric Observations. By W. Galbraith, Esq., A. M. Communicated by the Author.

I beg leave to communicate to you a few more barometric observations, to which I alluded in a former paper about two years ago. In that I calculated the height of Benlomond by a process depending on several tables which I had computed for the purpose, involving the dew-points at the two places of observation, and some other minor considerations, for purposes of extreme accuracy, as far as could by that method be obtained. Indeed there is no method, where great precision is required, that does not involve difficulties and sources of error in a greater or less degree. The variable nature of terrestrial refraction, the distance of the objects observed from the situation of the instruments in trigonometrical surveying on a grand scale, as that of the British Islands by the Board of Ordnance, all tend to involve circumstances that produce error. The barometric method is not, therefor more liable to error than the geometrical when performed trigonometrically, even with the best instruments, which are much more expensive, while the method of levelling, in the usual acceptation of the term, is seldom practicable for considerable heights. In the barometric method, the instruments are of moderate expense, especially the sympiesometer; and it will be seen, that, so far as my experience extends, the results derived from it are nearly of equal accuracy with those of the best mountain barometers, while its cheapness and portability are additional recommendations. It appears to me, however, that the sympiesometer requires rather more care in its use than the mountain barometer, on account of its being more rapidly susceptible of receiving impressions from a change of pressure from currents of air, from changes of temperature, and even, I am not sure that it does not occasionally suffer changes difficult to be accounted for from photometrical influence. All these circumstances require the observer to bestow great care in the use of it, so as to prevent any irregular influence to affect it unequally during the time of observation, on account of its extreme susceptibility. Though the mercurial barometer is a less suddenly susceptible instrument, yet the same care, nearly, must be employed when it is used, otherwise accurate results will not be obtained. Hasty observations should never be made, except from necessity, or where great precision is not required. I have repeatedly found, that when the observations are made too hurriedly, little confidence can be placed in them. To procure the utmost accuracy, good weather should be chosen, when the barometer is steady; two barometers should be used, one at the top of the height to be measured, and the other at the bottom, and the observations should be made at the same time, either by signal, or by watches set together at times previously agreed upon. The instruments should be protected from the sun, wind, and rain, or snow, in a tent, if circumstances and convenience permit, and they should be properly adjusted before making any observations.

From my experience, I am of opinion, that the attached and detached thermometers, in circumstances that permit, should be allowed to come to the same temperature before any observations from which computations are to be made, should be registered, though it would be right to note them, to know whether the barometer attained a state tolerably stationary. This appears to me necessary, for circumstances have occurred which I could not explain on any other principle than that, though the attached thermometer was nearly the same as the detached, yet I was persuaded that the comparatively large mass of mercury in the barometer tube and basin which communicated with it, had not attained the same temperature, which, of course, caused small variations in the height of the column, difficult to be accounted for on any other principle.

I may also remark, that when different barometers are employed, they should be carefully compared, to obtain their index errors, both at the commencement and termination of the operations, to detect any alterations which might possibly have taken place. On repeating the operations on different days, it would be useful for the observers to change their stations alternately from the top to the bottom. Indeed other precautions will occur to the experienced observer which the circumstances of the case and the nature of the situation seem to demand.

It sometimes happens, that the observer would think it convenient to obtain the height of objects when he has not access to tables or books, and in this case the sympiesometer would be most convenient, since the instrument performs the whole operation itself, with the exception of a simple multiplication. On the instruments now made, a small table is engraved, from which the factor answering to the sum of the temperatures at the top and bottom is immediately taken, by which the approximate height from the sliding scale is to be multiplied to produce the true height.

I shall endeavour here to investigate an easy formula, which will be readily recollected, to procure the same advantage nearly from the mercurial barometer, and then make a comparison of the results derived from these two instruments, from heights, where I have had an opportunity of employing them;—the first example, where they were used at different times,—the other, where they were used conjointly, and read simultaneously.

Since heights determined geometrically, are proportional to the differences of the logarithms of the altitudes of the mercurial columns, a formula may be derived from the usual series, for the computation of logarithms, thus:—

Let B be the altitude of the mercury at the lower station, and b that at the upper; then,

$$\text{Log. B} - \log. b = 2\,\text{M}\left\{\frac{\text{B}-b}{\text{B}+b} + \frac{1}{3}\left(\frac{\text{B}-b}{\text{B}+b}\right)^3 + \&\text{c.}\right\}\ldots.(1)$$

To apply this to the purpose required here, it will be necessary to obtain a constant factor, by which the difference of the logarithms must be multiplied, to give the heights in some known measure, such as English fathoms, or rather feet, which are now generally preferred. This number, from the observations of Ramond and the experiments of Biot, is 60155 English feet at the freezing point, or 32° of Fahrenheit's scale, and 2 M is 0·86858896, or twice the logarithmetic modulus; consequently $60{,}155 \times 0{\cdot}86858896 = 52{,}250$, the constant co-efficient at the freezing point.

In this country, as Fahrenheit's thermometer is very generally used, it would therefore be more simple, if reduced to zero of its scale. Now, the expansion or contraction of air in its ordinary state, for 1° of Fahrenheit, is about 0·0024, whence $52250 \times 0{\cdot}0024 \times 32 = 4013$. Hence $52250 - 4013 = 48237$, the co-efficient at zero of Fahrenheit's scale.

In practice, the mean of the temperatures of the air at the top and bottom is employed, wherefore, the result derived from the logarithmic series must be multiplied by the factor depending upon the product of the mean temperature, and the variation of the bulk of air for 1° increased by unity; or it must be multiplied by $1 + 0{\cdot}0024\left(\frac{t+t'}{2}\right) = + 0{\cdot}0012\,(t+t')$, t being the temperature at the bottom, and t' that at the top; wherefore,

$$48237 \{ 1 + 0{\cdot}0012 (t + t') = 48237 + 58 (t + t').$$

Or, to render the numbers more easily recollected, without much affecting the accuracy of the result, if H be the height required,

$$H = \left\{48000 + 60 (t + t')\right\}\left\{\frac{B-b}{B+b} + \frac{1}{3}\left(\frac{B-b}{B+b}\right)^3 + \&c.\right\} \ldots (A).$$

This is correct only on the supposition that B and b are reduced by calculation, or approximate tables, to the same temperature. But it is known from experience, that the height varies about 3 feet for every degree of difference of the attached thermometers at top and bottom. Now, if τ denote the temperature of the attached thermometer at the bottom, and τ' that at the top, then $-3 (\tau - \tau')$ must be the correction which is to be subtracted, when τ is greater than τ', otherwise added. Hence, finally,

$$H = \left\{48000 + 60 (t + t')\right\}\left\{\frac{B-b}{B+b} + \frac{1}{3}\left(\frac{B-b}{B+b}\right)^3 + \&c.\right\} - 3(\tau - \tau') \ldots (B).$$

The term $\frac{1}{3}\left(\frac{B-b}{B+b}\right)^3$ will always be very small, except in great heights, and need seldom be attended to, as the error for heights of about

5,000 feet, it will be nearly $\frac{1}{4000}$ of the whole.
10,000 .... $\frac{1}{400}$ ....

This term may therefore be safely rejected for any height usually measured barometrically; whence formula (B) becomes

$$H = \left\{48000 + 60 (t + t')\right\}\frac{B-b}{B+b} - 3 (\tau - \tau') \ldots\ldots\ldots\ldots (C).$$

To assist the memory, if $48000 + 60 (t + t')$ be denoted by c, $\frac{B-b}{B+b}$ by d, and $-3 (\tau - \tau')$ by e, formula (C) becomes

$$H = c\,d - e \ldots\ldots\ldots\ldots (c).$$

The whole of the numerical co-efficients are multiples of the number 3, the last of them; the second is twenty times the last, or $20 \times 3 = 60$; and the first is eight hundred times the second, or $800 \times 60 = 48000$, which is 16000 times the last, or

$16000 \times 3 = 48000$; which will afford some facility in recovering them when indistinctly remembered *.

We shall now proceed to the application of this formula.

Example I.

To determine the height of Allermuir, one of the Pentland Hills, the following mean of a number of observations, with excellent barometers, were taken after the manner of those employed to obtain the height of Benlomond, given in a former Number of this Journal.

The observations were made on the Calton Hill, of known height, 355 feet, with the Observatory barometer, by Mr Thomas Henderson, and on the summit of Allermuir, by myself, on the 26th of July 1828.

Inches.			
$B = 29.549$	$\tau = 65^{\circ}.4$	$t = 57^{\circ}.5$	
$b = 28.187$	$\tau' = 52.4$	$t' = 52.5$	
$B - b = 1.362$	$\tau - \tau' = 13.0$	110.0	
$B + b = 57.736$	3	60	
	-39	6600	
Constant		48000	
Correct co-efficient		54600	
$B - b$ reversed		263·1	
		54600	
		16380	
		3276	
		109	
$B + b$	57.736)	74365	(1288
		57736	— 39
			+ 355
		16629	
		11547	1604 = H
		5082	
		4618	
		464	
		462	
		2	

* It may be observed, that the number 60 is ten times the number of working days in a week, that the number 48000 is eight hundred times 60, and —3 is the twentieth part of 60, so that the whole of the co-efficients are derived from one number (6), the number of work days in a week, and by that means can hardly be forgotten.

By introducing a more refined calculation with logarithms, the height would have been about 10 or 12 feet more, though it is obtained at considerable risk of error, from errors either in the ordinary tables, or oversights in the steps of the calculation, which to unpractised persons frequently occur; whereas the foregoing requires only a very simple arithmetical computation, where no figure of real utility is suppressed, which is frequently done, to make the operation look simpler than it really is.

Example II.

On the 12th of September 1829, the following observations were made with Mr Adie's sympiesometer.

At Edinburgh, 270 feet above the sea.

$S' = 272$ fathoms, and $t = 57°{\cdot}7$ Fahrenheit;

At the top of Allermuir, on the same day,

$S = 490$ fathoms, and $t' = 50°{\cdot}3$ Fahrenheit;

Hence $S - S' = 490 - 272 = 218$ fathoms;

And $t + t' = 57°{\cdot}7 + 50°{\cdot}3 = 108°$, which, from the engraved scale on the instrument, gives the factor $m = 1{\cdot}053$;

Whence $218 \times 1{\cdot}053 = 229{\cdot}5$ fathoms, or 1377 feet.

If to this, 270 feet be added, for the height of the lower station, at Edinburgh, above the sea, we shall have 1647 feet for the height of Allermuir, above mean-tide at Leith. This exceeds the former by about 43 feet, which must be partly ascribed to the unfavourable state of the weather at the time, and partly to a small error in the foregoing formula. On the whole, I consider the mean of these results, or 1625 feet, to be nearly the true height, as I have found it from other observations.

Example III.

In the month of August 1830, with a mountain-barometer of the best construction, the following observations were made at

Fort-William, and on the top of Ben Nevis, to determine its height above the sea.

$B = 30.000$	$\tau = 51^\circ.5$	$t = 52^\circ.1$
$b = 25.466$	$\tau' = 37.7$	$t' = 37.0$
$B - b = 4.534$	$\tau - \tau' = 13.8$	$t - t' = 89.1$
$B + b = 55.466$	3	60
	41.4	5346

Constant		48000	
Correct co-efficient		53346	
$B - b$ reversed		435·4	
		213384	
		26673	
		1600	
		213	
$B + b$	55.466)	241870	(4360.9
		221864	− 41.4
			+ 50.8
		20006	
		16640	4370.3 = H
		3376	
		3327	
		49	
		49	

Example IV.

The same by the sympiesometer.

$S' = 155$ fath.	$t = 54^\circ$	
$S = 858$ fath.	$t' = 38$	
$S - S' = 703$ fath.	$t + t' = 92$	and $m = 1·033$.

Whence $703 \times 1·033 \times 6$ .... = 4357 feet.

Correction for height above the sea, at Fort-William, } ... = + 51

Height of Ben Nevis .... = 4408 feet above the sea.

Former height .... = 4370

Difference........ 38

A small quantity in so considerable a height, considering the simplicity of the last method.

As the weather was unfavourable, and the barometer changeable, with only one observer, who took the observations, first, at the bottom in the morning, then at the top about mid-day, and again at the bottom in the evening,—of which the mean of the first and last was reckoned the true height of the mercurial column at the bottom, there might have been some error arising from this cause. As the barometer continued to rise somewhat gradually, the error from this source must likely be small. At all events, whatever error attends the use of the one instrument likewise affects the other, since they accord so well when used together with equal care.

I have likewise calculated the height of Ben Nevis more rigorously by employing logarithms, and using the dew-points, besides other refinements, which would increase the height to about 4430 feet. As this exceeds all the heights I have ever met with attributed to it by at least 50 feet, I cannot say what confidence is to be placed in it, more especially, as I have been informed the Ordnance Surveyors make it only about 4360 feet, or 70 feet less. From the great distances of their stations, a very slight error in the angle of elevation, arising from the variable nature of terrestrial refraction, will produce a considerable error in their results in feet. Indeed, according to Mr B. Bevan's paper in the Philosophical Transactions for 1823, Part I., there are errors in the altitudes of some of the stations in England, of from 50 to 100 feet, in heights of between 700 and 900 feet! In this case I cannot say what confidence may be placed in that of Ben Nevis, though, in our measurement of Benlomond, the correspondence was as close as could be desired.

From the present measurements, too, it appears that the sympiesometer is an instrument which, when in good order, may be confidently trusted as giving results, when carefully used, very near the truth. The formula now investigated, appears to give results rather too small by about one-hundredth of the whole, and this is the reason why those by the sympiesometer seem to be, on comparison, too great. If one-hundredth of the height by the formula be added to itself, the final result would agree very closely with the logarithmic process.

54. South Bridge, Edinburgh.

On the Luxury of the Romans.

The Roman writers who flourished during the Republic say little about Natural History. It is more treated of by the writers under the Empire. But the works they have left us on such subjects contain few original remarks, and are little else than compilations, a circumstance which must appear very strange, since no nation had ever greater opportunities of observing.

In the earliest ages of the republic, besides that the Roman institutions were in general adverse to every kind of study, the simplicity of manners that prevailed was especially unfavourable to the progress of natural history, a science of luxury, expensive, and not to be carried on without many previous arrangements.

Indeed the relations among the beings that form the subject of natural history, cannot be established without bringing together a great number. Much assistance is therefore derived from commerce, drawing, as it does, towards a central point, the productions of foreign countries. Now, the Romans, during a very long period were not commercial. By the first treaty made with the Carthaginians, they bound themselves not to sail beyond the strait that separates Sicily from Africa. Still later, in the year of Rome 405, they gave up altogether their trade with Sardinia, and with the coast of Africa.

Commerce was checked, not through ignorance, but from the policy of their government, in order to withstand the introduction of luxury. Rome had no silver money till the 472d year from the foundation of the city, 268 years before Christ. At the date of the last Macedonian War, a senator was degraded from his rank for having ten pounds of silver plate. Gold plate was seen for the first time at the end of this war, in the triumph of Paulus Æmilius. But luxury was the speedy consequence of victory, and the luxury of individuals was carried to the utmost extravagance. We shall notice it in so far as regards natural history.

The luxury of the table, for example, caused to be imported into Rome from foreign countries a multitude of animals; of which several had no other recommendation but rarity, and being excessively dear.

The luxury of dress also is interesting, with respect to precious stones and dyes. That of buildings, on account of the marbles brought from different parts of Italy, from Greece, and even from Gaul. And the luxury of furniture is interesting, from the valuable woods employed.

Of the Luxury of the Table.

Quadrupeds.—During the second Punic War, Fulvius Hirpinus devised the mode of retaining quadrupeds in parks. These parks were named *Leporaria*, because three sorts of hares were reared in them, the common hare, the original Spanish rabbit, and the variegated or alpine hare, a species now almost entirely destroyed. In like manner, nearly all the native animals of our forests were bred in these parks, besides the wild sheep and the mouflon. These animals were almost domesticated, and were taught to unite at a signal. One day, when Hortensius was entertaining his friends at dinner in one of his parks, at the sound of a trumpet, stags, goats, and wild boars were seen running up, and gathered round his tent, to the no small dismay of some of the guests. Servius Rullus was the first who had a whole boar served on his table. Anthony, during his triumvirate, displayed eight at one feast. The Romans considered as a great delicacy the grey dormouse, a little animal that dwells in the woods, and in the holes of oak trees. They reared them in enclosures, and lodged them in jars of earthen-ware, of a particular form, fattening them with worms and chesnuts.

Birds.—Lenius Strabo of Brundusium invented aviaries for confining such birds, destined for the table, as could not be kept within the walls of a poultry-yard. It is he, says Pliny, that taught us to imprison animals whose abode is the sky. Alexander had introduced peacocks into Greece, where they were regarded only as objects of curiosity. Hortensius was the first who had one served at a banquet, when he was appointed to the office of augur.

These birds soon multiplied, and Ptolemy Phocion was astonished at the great number of them he found in Rome. Aufidius Lucro made about L. 600 a-year by fattening peacocks.

The peacock was a constant dish at all the great entertainments. It was the truffled turkey of those days.

Hirtius Pansa, who had the ill luck to give a feast where this indispensable article did not appear, was reckoned a niggard, a man without taste, and was ever after scorned by delicate feeders. In those aviaries thrushes and pigeons were bred. It seems, too, there were then the same fancies as there are at present. Certain varieties were much sought after. Varro relates that a couple of pigeons brought 2000 sesterces, about £19 of our money. Sempronius Lucius first had served on his table young storks. Geese were crammed in the same manner as now to enlarge their livers; but it was a dish too easily obtained, and soon those who wished to distinguish themselves invented new sorts of meat. They dressed the brains of ostriches, and the tongues of flamingos. Wild geese were sent for from Phrygia; cranes from Melos; and pheasants from Colchis.

Fishes.—As to fish, luxury went even farther than in birds and quadrupeds. At one period of the republic, a man eating a fish would have been thought shamefully dainty. But the severity of manners disappeared on the introduction of riches; and Cato complains, that in his time, a fish sold as dear as an ox. Yet, even then, Gallonius was publicly accused in the senate, and was nearly deprived of his rank, on account of the luxury of his table, having had sturgeons on it. The inventor of fish-ponds was Lucinius *Murœna,* and thence came the surname which was afterwards borne by this family.

Hortensius followed his example, and even went beyond it. Very soon, it was not enough to have fresh-water fish, for salt-water ponds were formed, in which were bred sea-trouts, soles, John Dories, and shell-fish of different kinds. Lucullus, in order to let in sea-water to one of his preserves, had a mountain cut through, and from this extravagance was deservedly called *Xerxes Togatus.* At his death there were so many fish in his ponds, that Cato of Utica, who was trustee on the succession, having ordered them to be sold, received for them the sum of £32,000 Sterling. The sale of the fish-ponds of Irrius yielded the same price. Cæsar wishing on a particular occasion to give a feast to the Roman people, applied to this Irrius for some lampreys. Irrius refused to sell any, but, according to Pliny, agreed to lend him six thousand. Varro says only two thousand. The object then was, who should be most absurd about lampreys. Hortensius had some of which he was more careful than of his slaves, and not for the purpose of eating them. Those served on his table were bought in the market. He is said to have wept on the death of one of these fish. Crassus, the orator, in a like case, went farther,—he put on mourning. His colleague Domitius chid him for it in the senate; but all this was nothing compared to the deeds of Vedius Pollio. He more than once threw in living men to be devoured by his lampreys.

Other fish were equally the objects of a prodigality of which we can hardly form a conception. The *accipenser* was generally sold for more than a thousand drachmæ. It was never set on the table without a flourish of trumpets. The *accipenser* was not, as it would seem, the ordinary sturgeon, but the sterlet, a small species with a pointed snout, caught in the rivers that fall into the Black Sea. The mullet, or roach of Provence, called in Paris the *sun-mullet*, was also sold excessively dear. A mullet weighing 4 pounds fetched £37; another £62. Three together, in the reign of Tiberius, were sold so high as £250. These fish used even to be brought alive to the dining-room, by canals filled with salt-water, which passed under the table. The fact is undoubted, and is attested by the invectives of Seneca.

Snails and Oysters.—Singular attention was likewise paid to snails. The same Fulvius Hirpinus, who had thought of parks for quadrupeds, contrived parks for them too. As snails could not be retained by inclosures, the places in which they were kept were surrounded with water. Jars of earthen-ware were set for them, to retire into, and they were fattened with mulled wine and flour. Pliny says there were some of the weight of 25 lb. Those that grew to this size were certainly not Italian snails. But we know that snails were likewise brought from foreign countries, as Africa and Illyria.

The man who first shewed the way of making oyster-beds was Sergius Aurata. He, like Licinius, derived his surname from a fish, the John Dory. The preserver of the Lucrine

Lake had for a long time the character of producing the best oysters. Next to them were those of Brundusium. At last refinement was carried farther; and the oysters of Brundusium were taken to be parked in the Lucrine Lake.

Fruits.—It appears that fruits were less sought after then than they have been since. The only new fruit introduced at this time was the cherry, which Lucullus brought from Cerasus, a town in Asia Minor, sixty-nine years before Christ.

Perfumes and Dress.—The luxury in *perfumes* was beyond measure, and drew to Rome the most costly aromatics of the East. The luxury of *dress* was equally great, and made known purple, pearls, and precious stones. At one time there was quite a rage for opals; and one individual, rather let himself be prosecuted, than give up to Sylla a very fine one the dictator desired to have.

Furniture.—The dominion of fashion extended equally to *furniture*, and raised the value of certain kinds of wood to an enormous amount. For a while the *citrus* was preferred. The tree thus named was not the citrus of Theophrastus, the orange-tree of our time; but seems to have been a species of Thuya, brought from Cyrenaica. They made use not only of the trunk, but of some knots that grew out near the root. When such pieces could be got of a large size, they were sold excessively dear. Cethegus paid for a table 1,400,000 sesterces, about £11,000. Even Seneca, with all his outcry against luxury, had some tables that cost a most exorbitant sum. These pieces were distinguished by their colour, and by the way they were veined. Each variety had a different name. Ebony also was employed, a kind of wood first introduced into Italy by Pompey, after his victories over the pirates.

Building.—A great deal of marble was used in building. It was brought from the most distant countries, and there were even several of which the quarries are now lost. Thus the marbles denoted by the names of *vert antique* and *rouge antique*, are so termed because they are found only in ancient structures. It was in searching for such fragments among some ruins that Pompeii was discovered.

Luxury of the Empire.—If from the luxury of individuals we turn to the luxury displayed in public festivals, we find still greater matter of astonishment. One would hardly venture to repeat what is stated in ancient writers, yet there appears no ground for supposing that they exaggerated, seeing how closely their accounts agree; when we reflect, too, that they were nearly all eye-witnesses of what they relate, and that they would not have attempted to bring forward assertions opposed to the knowledge of all their contemporaries. Messrs Beckman, Mongez, and Cuvier, have made very extensive inquiries about the animals exhibited or slain in the circus. Such inquiries ought not to be regarded as merely curious. In fact, it is of importance to the naturalist, and for several reasons, to know the date of the first appearance of these animals, the countries of which they were natives, and their numbers. For example, without ascertaining these points, a naturalist would often be apt to mistake the bones of foreign quadrupeds for true fossil remains, and thus to mistake transported soil for regular formations.

Curius Dentatus first shewed foreign animals at Rome in the year 273 before Christ. It will be recollected, that elephants were first brought to Greece during the conquests of Alexander. Aristotle saw them, and wrote about them a great deal better than Buffon has since done. These elephants, and some others sent afterwards, came into the possession of Pyrrhus, king of Epirus, who had taken them from Demetrius Poliorcetes. Pyrrhus having been himself defeated by the Romans, four of his war-elephants fell into the power of the conquerors. These elephants, after having been led in the triumphal procession of Curius, were slain before the people. Four-and-twenty years later, Metellus, having gained a great victory over the Carthaginians, captured a hundred and forty-two elephants, which were all slain with arrows in the circus. It was evidently good policy, in the time of Curius Dentatus, to put to death some of these animals, in order to lessen the fear the sight of them had at first produced. There were not the same reasons for the second massacre; but, without doubt, the Romans had no desire to introduce elephants into their armies, and thus oblige themselves to alter tactics of which they had proved the excellence. As little were they inclined to make a present of these elephants to any of the kings their allies, from an apprehension of adding too much to their force. Sixty-six years after the triumph of Metellus, in the year before Christ 186, Marcus Fulvius, to absolve himself from a vow he had made in the Ætolian war, exhibited panthers and lions. These animals might have come from Africa; but perhaps he had obtained them from Asia Minor, where, at this time, some were still to be found. The people getting a taste for these shows, Scipio Nasica and Publius Lentulus gave them a sight of several elephants, forty bears, and fifty-three panthers. Quintus Scævola had several lions fighting against men. Sylla had more than a hundred male lions. In the year 58 before Christ, Æmilius Scaurus, during his ædileship, distinguished himself not only by the number of animals he brought out, but also by presenting several that had never before been seen in Rome. In these spectacles the first hippopotamus appeared. There were also five live crocodiles, five hundred panthers, and, more strange still, the bones of the animal to which, it was said, Andromeda had been exposed. These bones had been brought from the town of Joppa (Jaffa), on the coast of Palestine. There were among them vertebræ a foot and a half long, and a bone not under six-and-thirty feet in length, probably the under jaw of a whale. In the year 55 before Christ, Pompey, at the inauguration of his theatre, displayed a lynx, a cephus, from Æthiopia (a species of ape), a one-horned rhinoceros, twenty elephants fighting with men, four hundred and ten panthers, and six hundred lions, whereof three hundred and fifteen had manes. All the sovereigns of Europe together could not now produce such a number. Cicero, who was present at these games, speaks of them with great disdain, and says the people at last took pity on the elephants. In the 48th year before Christ, Anthony exhibited lions harnessed to a chariot; it was the first time these animals had been seen so employed, but they were not the first that had been tamed. A Carthaginian, named Hanno, had a lion that followed him through that city like a dog. His trouble was ill rewarded, for his countrymen banished him, judging that a man who had been able to subdue a ferocious beast, must have been gifted with some secret power by which he might perhaps have overcome themselves.

In the year 46 before Christ, Cæsar put forth, in an amphitheatre covered over with a purple awning, four hundred maned lions, several wild bulls fighting with men, and twenty elephants which were attacked by five hundred infantry. On the evening of his triumph, he returned home preceded by elephants carrying torches.

We may imagine the unbounded opulence of the men who could afford such spectacles—the eagerness of allied kings to gratify them—the crowds of human beings employed in obtaining the animals exhibited to the people! It is not less astonishing that it was possible to collect such a multitude of large animals and beasts of prey.

Yet in this kind of munificence the great Romans of the republic were afterwards outdone by the emperors. From an inscription, in honour of Augustus, found at Ancyra, we learn that this prince caused three thousand five hundred wild beasts to be slain before the people. On one occasion he had water brought into the circus of Flaminius, and shewed thirty-six live crocodiles torn to pieces by other savage animals. Two hundred and sixty-eight lions were killed at this entertainment. There was besides, a serpent fifty cubits long, a python from Africa, and a royal tiger confined in a cage, the first that had been seen in Rome. Augustus, before he became emperor, at his triumph over Cleopatra, had a reindeer and a hippopotamus slain in the circus. Germanicus, at his triumph over the Germans, brought out elephants that had been taught to dance. Caligula gave four hundred bears and four hundred panthers to be killed. Claudius, at the dedication of the Pantheon, displayed four live royal tigers. A mosaic pavement, which has lasted till our time, represents these animals of their natural size. The same emperor, having been informed that a whale was stranded in the harbour of Ostia, repaired thither, and engaged the monster with his galleys. The animal was probably a large species of dolphin, the *orca*. Galba shewed an elephant that went up on a tight rope to the summit of the theatre, with a Roman horseman on his back. These elephants were instructed when they were young, for they were born in Rome. Ælian says so positively, in speaking of the elephants of Germanicus. Mr Corse Scott has shewn, in opposition to the opinion of Buffon, that elephants, by taking certain precautions, will breed in a state of domestication. But the fact was known in Italy from the time of Columella.

This lavish expenditure continued during the four first centuries of the Roman empire. Titus, at the dedication of his baths, placed in the circus nine thousand animals, and exhibited cranes fighting together. Domitian gave hunts by torch-light, where the two-horned rhinoceros appeared,—an animal with which Sparrman has made us acquainted only within the last sixty years, though it is engraved on the medals of Domitian. In these games a woman fought with a lion. An elephant, after having trampled to death a bull, went and knelt to the emperor; a royal tiger killed a lion; and wild cattle dragged chariots. Martial has occupied a whole book with the description of the games of Domitian. In his epigrams naturalists will find many curious hints.

Trajan, after his victory over Deceballus, king of Parthia, gave entertainments that lasted three-and-twenty days. According to Dio Cassius, eleven thousand animals perished at them. But the accounts of historians are much less interesting, than a mosaic, executed by order of that emperor. In this valuable fragment, which was discovered at Palestrina, the ancient Præneste, the animals of Egypt and Ethiopia are figured with the names under each of them. The lower part represents the inundation of the Nile. The forms of the ibis, the crocodile, and the hippopotamus, are very exactly given. But the hippopotamus has been very ill described by the Roman naturalists, who have only copied from Herodotus. On the upper part of the mosaic there appear among the mountains of Ethiopia the giraffe, under the name of *nabis;* apes, and various reptiles; in all thirty animals, easily recognised, and whose nomenclature is thus determined.

Antoninus, the successor of Adrian, conforming to the established usage, likewise exhibited games. He had crocodiles, hippopotamuses, strepsiceroses (antelopes), and hyænas different from those described by Agatarchis.

Marcus Aurelius abhorred such spectacles, but his son Commodus resumed them with fury; with his own hand he slew a tiger, a hippopotamus, and an elephant. He sent into the circus a great number of ostriches, and as they ran about cut off their heads with crescent-shaped blades, fixed on the points of arrows. Herodian, who relates the fact, says, that the birds, after being decapitated, ran about for some time. The experiment has been successfully repeated on ducks. Septimius Severus, in the tenth year of his reign, at the rejoicings on the marriage of Caracalla, made four hundred animals come out of a machine, and among them some wild asses and bisons. At the marriage of Heliogabalus, there were chariots drawn by all kinds of wild beasts.

The most expensive and most curious assemblages of animals were those of the Gordians. The first emperor of this name in one day exposed to view a thousand panthers. Probus, one of their successors, had trees planted in the circus. More than a thousand ostriches, and a countless throng of various creatures, were seen running about in this artificial forest.

So long as the Roman empire existed in the west, similar displays were continued. In spite of the prohibitions of Constantine, there were some even under Christian emperors. Theodosius gave fights of animals in the circus; and Justinian himself exhibited in the amphitheatre twenty lions and thirty panthers.

Such sights, repeated without interruption for more than four hundred years, must have afforded the Roman naturalists opportunities of making numerous observations on the forms, habits, and interior organization of foreign animals; yet science was little improved by their labours. It seems, that the animals being once killed, nobody derived any further benefit from their slaughter. The proof is, that all the writers of the first, second, and third centuries of the Christian era, who have treated of such animals, have borrowed every thing they have said about them from Greek authors who lived before the Roman conquest. Pliny himself is but a compiler.—*From a Lecture delivered by Baron Cuvier.*

*An Account of a Peculiarity not hitherto described in the Ankle, or Hock-joint of the Horse; with Remarks on the Structure of the Vertebræ in the Species of Whale, entitled Delphinus Diodon**. By Robert J. Graves, M. D., M. R. I. A., King's Professor of the Institutes of Medicine, Honorary Member of the Royal Medical Society of Berlin, of the Medical Association of Hamburgh, &c. &c.

Being engaged in the dissection of the horse, on examining the hock-joint, I found that any effort to flex or bend the limb at that joint, was counteracted by a considerable resistance, which continued until the limb was bent to a certain extent; after which, suddenly and without the aid of any external force, it attained to its extreme degree of flexion. In attempting to restore the extended position of the limb, I found that a similar impediment existed to its extension, until the same point was passed, when the limb suddenly, as it were, snapped into its extreme degree of extension at this joint.

At first I conceived that this phenomenon depended on the tendons of the flexor and extensor muscles of this joint; but on removing all these muscles and their tendons, it was not diminished, and it therefore became clear that it depended on some peculiar mechanism within the joint itself.

Before I enter into the details of this mechanism, it is necessary to remark, *that it is evidently connected with the power this animal possesses, of sleeping standing*, for it serves the purpose of keeping the hock-joint in the extended position, so far as to counteract the oscillations of the body, without the aid of muscular exertion; and in this respect it resembles the provision made to effect a similar purpose in certain birds, as the stork, and some others of the grallæ, which sleep standing on one foot. It will appear, also, in the sequel, that not only is the effect produced the same, but the mechanism is in many respects similar, if the account given by Cuvier, and also by Dr Macartney, in Rees' Cyclopædia, article *Birds*, be correct.

* Read 5th July 1830, before Royal Irish Academy, and just published in the Memoirs.

Sheep and cows are not provided with ankle-joints of a similar structure, and it is well known that these animals do not possess the power of sleeping standing. Another circumstance which adds additional interest to this peculiarity of structure, is, that it may possibly be connected with the disease termed *String-halt*, in which the limb is at each step suddenly flexed, to a degree far beyond that required in ordinary progression. Whether this is owing to a sudden and jerking flexion of the whole limb, or to flexion of the hock-joint alone, I have had no opportunity lately of determining. If the latter be the case, it is probably connected with the structure of the hock-joint, which I am about to describe. It may be right to observe, that not even a probable conjecture has been advanced, concerning the nature and cause of string-halt, a disease to which the sheep and cow are not subject, and we have already observed, that in these animals the structure of this joint presents nothing remarkable.

The hock-joint is a good example of what is termed the hinge-like articulation, and is formed between the tibia and astragalus, which latter bone presents an articulating surface, with a nearly semicircular outline, and divided into two ridges, including between them a deep fossa. The tibia is furnished with depressions which ride upon the ridges of the astragalus, and has anterior and posterior projections, which, moving in the fossa, are received into corresponding depressions in the astragalus, at the moment the limb arrives at the greatest degree either of flexion or of extension.

The shape of the surfaces of the astragalus concerned in the articulation, is not that of a given circle throughout, for towards either extremity, the *descent is more rapid*, or, in other words, answers to an arc of a smaller circle. Hence, when one of the projections of the tibia has arrived at its corresponding cavity in the astragalus, which happens when the limb is either completely flexed or completely extended, the rapid curve of the articulating surface presents a considerable obstruction to change of position. Thus, the form of the articulating surfaces, in itself, to a certain degree, explains the phenomenon ; but its chief cause is to be found in the disposition and arrangement of the ligaments.

The external malleolus of the tibia is divided by a deep groove, for the passage of a tendon, into an anterior and posterior tubercle; from the latter of which, and close to the edge of the articulating surface, arises a strong and broad ligament, that is inserted into the os calcis. Under this lies another ligament, which, arising from the anterior tubercle, is also inserted into the os calcis. It is to be observed, that the origin of the latter is anterior to that of the former, but its insertion posterior, so that these lateral ligaments cross each other in the form of an ×. The external articulating protuberance of the astragalus on which the tibia revolves, has, as has been already stated, a nearly circular outline, and the attachments of the ligaments just described, are at points on the outside of the os calcis, which would lie nearly in the circumference of that circle, were it continued from the articulating surface; so that each of these ligaments has one of its extremities fixed in a certain point of the circumference, while its opposite extremity revolves during the motion of the joint, nearly in the circumference of the same circle. This observation applies likewise to the two lateral ligaments on the inner side of the joint, which have nearly the same relation to each other, and to the general contour of the joint, as that just described; so it is obvious, that during the rotation of the joint, as the origins of these ligaments move along the same circumference in which their attachments are fixed, the ligaments will be most stretched when they correspond to diameters of that circle.

Now it is so arranged that this happens at the same time for all, and consequently the ligaments on each side correspond not merely as to direction, but as to the point of time they become most stretched, which is nearly at the moment that the joint has no tendency to move either way, and at that moment, it is to be observed, that although the ligaments are most tense, and of course react on their points of attachment with greatest force, yet this produces no motion, as the force is exerted in a direction perpendicular to the circumference; but as soon as the tibia is moved beyond this point of inaction for the ligaments, the latter, no longer representing diameters, by their contractile force evidently tend to accelerate the motion; and as they all act in the same direction, and are assisted by the shape of the articulating surfaces, a sudden motion of flexion or extension is thus produced.

The preceding explanation supposes the ligaments of this joint to possess, contrary to the nature of ligaments in general, a certain degree of elasticity, which was evidently the case in all, *but particularly* in the most deep-seated of those on the inner side of the joint, which, therefore, appears most concerned in producing the sudden motion, whether of flexion or extension.

In the autumn of 1829, two of the species of whale called Delphinus diodon, by Hunter, Hyperoodon, by La-Cepede, and Cetodiodon, by Dr Jacob, were captured near Dublin, one of which, measuring about sixteen feet in length, I procured for the purpose of preparing its skeleton.

After the spinal column had undergone maceration for a few days, I found that the intervertebral substance could be easily detached from the bodies of the vertebræ, and that it carried with it, firmly attached to each of its extremities, a flat circular bone, about a quarter of an inch in thickness, and exactly corresponding in the extent and shape of its surface, to the surface of the body of the vertebra, from which it had been separated.

The separation was effected with facility, and took place spontaneously and completely when the maceration had been continued some time longer.

The surface of the flat bone, where it had been adherent to the body of the vertebra, was of a spongy texture, afforded a passage to many bloodvessels, and was marked by numerous sharp projections and deep furrows, diverging from its centre, and answering to similar projections and furrows on the denuded extremity of the vertebra; of course the surface of these bones varied in shape and size with the extremities of the vertebræ to which they were attached, being from five to six inches in diameter at the dorsal, and not more than one inch at the last caudal vertebra.

The substance of these bones towards the intervertebral substance was of much harder and closer texture than that of the bodies of the vertebræ themselves, and where it was adherent to the intervertebral substance, it had a smooth surface, marked with a great number of concentric lines, answering to the arrangement of the fibres in the intervertebral tissue, which adhered to this face of the bone with great strength. This marking was deficient towards the centre where the intervertebral substance is fluid.

The facility with which these bones are detached, is the reason why we never find them adhering to the vertebræ of those young whales which have been wrecked on our coast, and whose skeletons have been exposed to the action of the waves and the weather. Their flat shape, too, renders them liable to be covered by the sand, and hence I have never known them to be found separately, even when the vertebræ and other bones of this species of whale were scattered along the coast in great numbers, as happened at Dungarvan some years after several of these animals had been captured and dragged ashore by the fishermen *.

The bones I have described must evidently be considered in the light of terminal epiphyses of the bodies of the vertebræ, and are deserving of notice on account of the facility with which they can be detached, *even in very large, and of course not very young, animals of this species,* as I observed in the two skeletons preserved in the College of Surgeons, one of which measures thirty feet in length; so that when the skeleton has been artificially prepared, they resemble separate intervertebral bones rather than vertebral epiphyses. In the land mammalia the consolidation takes place much more rapidly, and a few years are sufficient to efface all traces of former separation between the epiphysis and the body of the vertebra; the comparative slowness of this process in the whale, is probably referrible to the longevity of the animal, and the greater length of time necessary to complete its growth. A knowledge of this fact puts us in possession *of a new and useful mark of the animal's age, independent of its size,* and it is for this purpose I have brought it forward, for although not noticed by any author I have seen

* Many years ago we picked up several of these intervertebral looking bones, upwards of a foot in diameter, on the shore of the island of Yell, one of the Shetlands. In their neighbourhood was a skeleton of a whale, about 40 feet long, part of which we brought to Leith.—Edit.

on the Anatomy of Whales, it must, nevertheless, have been known to several. If we find that the terminal epiphysis has become completely united to the body of the vertebra, we may be assured that the bone, whether large or small, belonged to an animal arrived at maturity; but if not, we may conclude that it had not yet attained to its greatest size. To facilitate this inquiry, I may remark, that a very slight examination of a vertebra is sufficient to determine, whether the epiphysis has or has not been detached; as in the former case the surface is *marked by deep ridges and furrows diverging from the centre towards the circumference*; whereas in the latter, if the animal was of moderate size, the marking consists of concentric lines, answering to the attachments of the intervertebral substance; and if the individual was very large, these concentric lines are exaggerated into concentric furrows; and whether the attachments of the intervertebral substance be marked by concentric lines or by concentric furrows, *a considerable portion of the central part of the bone, where it had been in contact with the internal substance of the intervertebral ligaments, is quite destitute of this marking*, and presents a striking contrast to the rest of the surface.

I am not aware that the true cause of this remarkable difference between the markings on the extremities of the vertebræ of the cetacea has been before explained.

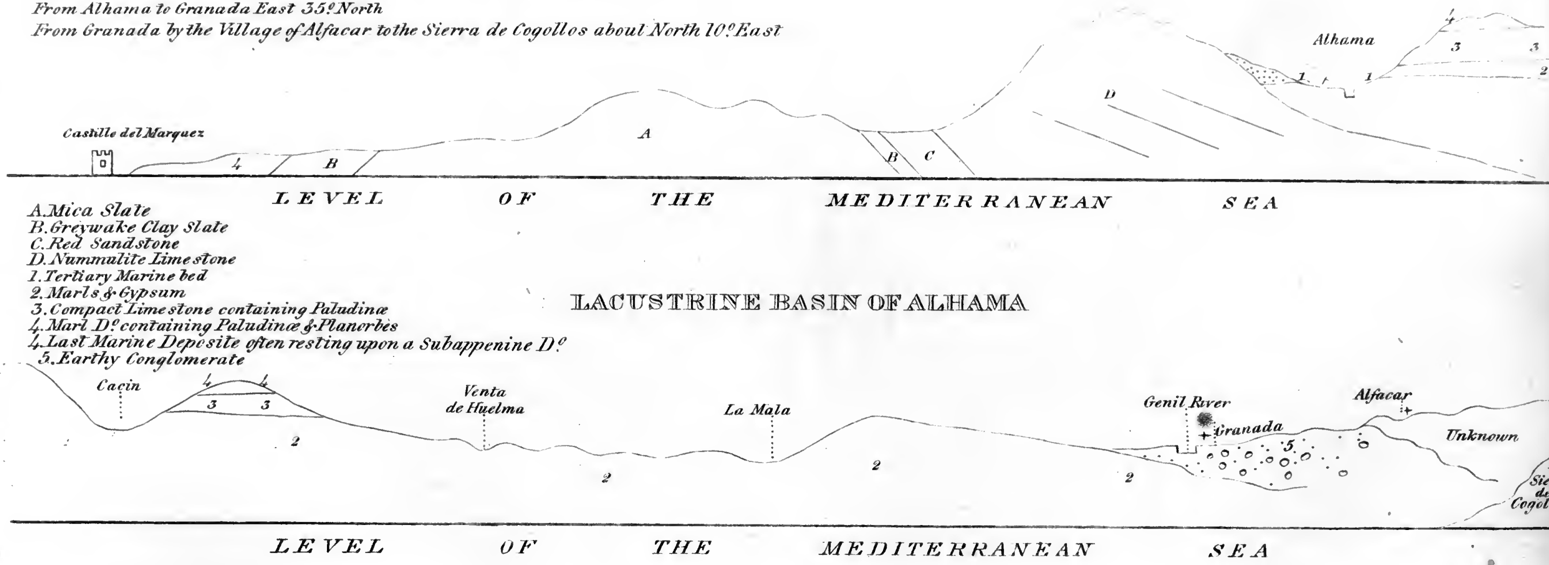
It may not be uninteresting to add, that the cranium of the Delphinus diodon in my possession, and both those in the Museum of the College of Surgeons, present, in a very remarkable manner, the want of symmetry between the right and the left sides of the cranium, which was first observed by Meckel in the skulls of the cetacea.

Note.—Since the preceding notice concerning the hock-joint of the horse, was submitted to the Academy, I have had an opportunity of examining two horses affected with string-halt, and am inclined to attribute the disease to a spasmodic affection of the flexors of the limb generally, rather than to any derangement in the structure of the hock-joint. It may be right to mention, that the following authors on Comparative Anatomy, and the Anatomy of the Horse, have been searched, but they contain no notice of the peculiarity in the structure of the hock-joint, above described :—Macartney, Cuvier, Carus, Blumenbach, Meckel, Clater, Blaine, Stubbs, Percivall, Boardman, White, Lawrence, Osmer, Home, Bourgelat.

PLATE I.

Section from a Fort called Castillo del Marquez near Velez Malaga on the Southern Mediterranean coast of Spain to the Sierra de Cogellos about Six miles north of the city of Granada

From Castillo del Marquez to Alhama nearly North 20° East
From Alhama to Granada East 35° North
From Granada by the Village of Alfacar to the Sierra de Cogollos about North 10° East



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E. Mitchell Sculp.t

On the Lacustrine Basins of Baza and Alhama, in the Province of Granada in Spain. By Colonel SILVERTOP, M. G. S. L. Communicated by the Author.—*(Concluded from former volume, p. 349.)* With a Plate.

BASIN OF ALHAMA.

THE geographical position of this basin was alluded to in general terms at the commencement of my last communication. It occupies a large circular area, at the distance of about fifty miles to the south-west of that near Baza, on the northern side of the primitive and transition chain of mountains which border the Mediterranean; and it is chiefly surrounded by primary rocks towards the south and east, and by ridges of secondary limestone towards the north and west *. In the latter, close to a town called Loja, at the western extremity of the basin, there is a chasm through which the river Genil †, rising in the Sierra Nevada to the east of Granada, is enabled to escape, and to pursue its course to the Guadalquivir; but beyond this chasm the secondary limestone is continued, and, circling round towards the east north-east, forms the boundary of the basin towards the north. A considerable portion of this ridge is known by the name of Sierra de Cogollos, and the distance from it to the opposite ridge near Alhama, may be taken as the greatest length of the basin; that from a village called Escuzar, on its eastern side, to the town of Loja, as its greatest breadth; the former being equal to about thirty-six, the latter to about thirty miles. One insulated group of transition limestone, named La Sierra de

* In the southern boundary of this basin, a junction between the primary and secondary rocks occurs between a pass called El Puerto de Zafarraya and the western flank of a high mountain, well known to botanists, and called La Sierra de Tejeda: in the northern boundary a similar junction takes place, near a village called Huetor de Santillana, about four miles from Granada, on the road to Guadiz. At neither of these points, however, is there any interruption of continuity in the bounding ridges, the secondary limestone in both instances appearing to come in contact with, and to rest upon, primary rocks of a similar composition or basis; that near Huetor being a granular, that of Tejeda a lamellar limestone, and both highly crystalline.

† The classic vale, the Vega de Granada, watered by the Genil, has been immortalized in song and in prose, as the theatre of many a chivalrous deed in the *olden times*.

Elvira, near Granada, is seen within this area: with this exception, the whole of its superficies is occupied by conglomerates, marl, gypsum, and other tertiary beds; the conglomerates predominating to the north and east of Granada, and forming a high tract of waving hilly ground between this city and the Sierra Nevada; the latter prevailing to its south, or from the left bank of the river Genil to the ridge which confines the basin in the latter direction. The upper stratum of the valley of the Genil, which occupies the lowest relative tract in this basin, is generally composed, near Granada, of a disintegrated conglomerate, an argillaceous marly deposit, with innumerable rounded fragments of the neighbouring primary and transition rocks; but lower down it often consists of a sandy loam. The rising ground from this valley in the direction of a village called Cogollos, situated at the base of the ridge which bounds the basin towards the north, exhibits a high, broken, irregular tract, consisting of a calcareous marly deposit, with some beds of marly sandstone two or three inches thick, and containing, as I was informed, some beds of lignite *. Near Alfacar, another village upon this slope, there is an extensive *formation* of calcareous tufa, which is quarried, and has furnished the material with which several of the churches in Granada have been built †: it passes in some places into beautiful alabaster, which receives the most brilliant polish, and is worked into slabs, vases, and other ornamental figures.

There is one circumstance perhaps worthy of being noticed, connected with the conglomerate hills between Granada and the Sierra Nevada. A stream called El Daro, taking its rise near the village of Huetor de Santillana, and entering the Genil at Granada, winds its intervening course between high hills of this deposit. After heavy rains have increased the volume and rapidity of its waters, and transported to its bed the loose materials of the adjoining hills, it is not unusual to find particles of *gold* disseminated in the sand and mud deposited after the tor-

* I had no opportunity to examine this tract, but presume it to be tertiary.

† Extensive deposits of calcareous tufa are observable in many parts of the south of Spain, generally along the bases of limestone ridges. Natural excavations in these constitute caverns, often of singular beauty; that called St Michael's at Gibraltar, is well known.

rent; and the labourers also occasionally discover them in ploughing the disintegrated surface of the contiguous tract.

Having stated these general and preliminary observations, I shall proceed to notice, *first*, the appearances presented along the line of road * from Granada to Alhama; and, *2dly*, offer a more minute detail of the tertiary beds, displayed in the neighbourhood of the latter village.

1. *From Granada to Alhama* †.

After crossing the Genil, which flows by the side of the beautiful Alameda ‡ of Granada, the road proceeds for about four miles over a horizontal plain in a fine state of cultivation, the upper stratum of which consists of a disintegrated earthy conglomerate, although in some places it exhibits a sandy loam. Beyond the little village of Gavia, the ground begins to rise and assumes a marly character. In several hillocks adjoining the line of road, white granular gypsum is observed alternating with thin strata of indurated marl, and, indeed, generally comes to day on each side of the road, and at times constitutes its foundation, during the gradual ascent to the summit of a considerable hill it crosses before reaching the village of La Malā. From the west of the hill to this village, which is about eight miles distant from Granada, there is a long descent, during which the road passes over three different beds of gypsum identical in structure and colour to that last mentioned, the intervening spaces exhibiting light earthy marl which separates strata of indurated marly sandstone abounding in small shining particles of mica, and from one to four inches thick. The latter alternate with layers of fibrous gypsum half an inch thick, and with other laminæ not two lines in thickness, whose cross fracture displays minute almost microscopic leaves, if I may be allowed so to call them, of this mineral, accompanied by others equally delicate of arenaceous marl, the surface of which is generally resplendent with a confused crystalline investment of the same mineral. There is great variety and apparent confusion in the dip of all these strata and their alternating laminæ, most of which, however, incline at a considerable angle towards the south-west, but

* This is the *horse* road from Granada to Malaga.

† See section from Mediterranean to Granada. ‡ Public walk.

many of them dip in an opposite direction, the latter being the case on the Granada side of the hill, the former in the subsequent descent towards La Malā; but in a hill at a short distance from the road, and only separated from that it crosses by a deep ravine, a series of these strata was observed in a nearly horizontal position, jutting out beyond the earthy marl that separates them. In the bed of the little stream which passes by La Malā, there is a *brine spring*, the water of which, by means of a Noria or Moorish pump, is elevated into a series of reservoirs or quadrangular basins, where it is evaporated by the heat of the sun during the summer months, and the salt sold by the government to the neighbouring villages *.

Beyond La Mala, there is a gentle ascent where gypsum is seen in considerable abundance, the road passing over a series of its inclined laminated strata from one to three inches thick, and in structure and colour identical with that which was before observed.

Hence to a public-house, called La Venta de Huelma, four leagues from Granada (about 16 miles), there is an undulating cultivated tract of a light marly nature, where gypsum rarely comes to day, but close to the Venta some insulated masses of it are observed ; and near a village called Escuzar, about three miles distant in an easterly direction, this mineral, of a beautiful whiteness, is met with in abundance, quarried and worked into various ornaments connected with the religious ceremonies of Spain. From this house onwards towards Alhama, the country becomes more hilly, and the road, after passing over a bed of stratified gypsum in the first ascent beyond the Venta, traverses a higher undulating tract, a sort of southern heath, covered with wild thyme, esparto †, and evergreen shrubs. At the commencement of this tract, a few insulated strata of a calcareous nature

* About six hundred thousand pounds of salt are annually made here. This article is a monopoly of the government, and each householder in the villages is obliged to receive every year the quantity of it portioned out to them by the justicia or magistracy at the government price, which is exorbitant.

† The Esparto is a grass of the rush tribe, whose botanical name is, I believe, *Stipa tenacissima*. It is a great object of industry in the south of Spain, from which all sorts of ropes and cordage, as well as mats of various qualities and beauty, are made.

are first observed to cap some of the low hills and eminences at a little distance from the road towards the left, whose nature will be soon more fully explained. On reaching the highest part of the tract between the Venta and a village called Cacin, distant from the former about six miles, a portion of its summit is observed to be crowned by a bed of compact limestone, containing moulds of paludinæ, superimposed to which, irregular masses are seen of a marly limestone, almost entirely composed of comminuted shells, amongst which paludinæ, lymneæ, and planorbes, are distinctly visible. But here this calcareous mass has little thickness, not exceeding, I should think, thirty feet; and, from the irregularity in position of some of the strata, which are from four inches to three feet thick, as well as from the state of decomposition of the rock, it has the appearance of having been considerably broken up and affected by external agents. From this point to the little village of Cacin, situated upon the right bank of a stream bearing the same name, there is a long descent, in the first part of which, immediately below the calcareous bed just alluded to, the road for a considerable space passes over a bed of white finely granular gypsum, in strata about an inch thick. The subsequent part of the descent exhibits a marly earthy mass, whose surface is strewed with fragments from the limestone capping the hill; but gypsum is again observed, and has been worked by perpendicular cuts, along the immediate bank of the rivulet. The bed of this is nearly a quarter of a mile in breadth, a small portion of which only is occupied by two little channels in which the rivulet flows, the remaining portion being partly under cultivation and partly planted with willows and poplars. A low cliff of conglomerate bordering the right bank, and in places abutting against the contiguous gypsum, attests the powerful body of water which in some ancient time has rushed down this little valley of denudation.

The frequent, almost continued appearance of gypsum, from the rising ground near the village of Gavia to this point, and the similarity in physical character and aspect of the intervening tract, appear to countenance the presumption, that the whole of it is occupied by a deposit of the above-mentioned substance, associated with various proportions of marl in an earthy or indurated state. No other rock is seen, until a few strata of fresh-water limestone begin to cap one or two eminences near the Venta de Huelma, and again, in a more considerable but insulated mass, crown a portion of the hill previous to the descent to Cacin. Immediately under this mass, on the Cacin side, as also along the right bank of the rivulet at the bottom of the descent, gypsum is observed in great abundance, as has been already noticed. It would, therefore, appear that this gypsum formation is immediately subjacent to the fresh-water or compact paludinæ limestone, which, as will shortly be seen, becomes the predominating and superior * rock in the southern portion of the basin, and constitutes a ridge of considerable elevation between Cacin and Alhama.

At the commencement of the ascent beyond Cacin to this ridge, gypsum imbedded in marl is again observed; but higher up it is succeeded by horizontal strata of compact, somewhat vesicular limestone, of a dingy whitish colour, containing here and there casts or moulds of paludinæ. Still higher up the ascent, and subsequently crowning in a partial manner its summit, the marly limestone, formed of broken shells, and distinguished by the presence of planorbes, as well as of lymneæ and paludinæ, makes its appearance, overlying the former. These two limestones continue to be observed in the same order of superposition nearly to the bottom of a broad denuded hollow in the ridge, and during the subsequent ascent. The highest part of the ridge presents an irregular sort of table-land, covered with wild plants and shrubs. Its total width is between seven and eight miles. In the long gradual descent to the rivulet of Alhama, cultivation generally prevents the subjacent beds from being seen until near its termination, when a few horizontal strata of calcareous sandstone are observed, whose geognostical relations will soon be made evident. The road then passes a bridge over the last mentioned stream, which has worked its way or penetrated at this point through a little insulated mass of secondary nummulite limestone, manifesting in some places, as I have frequently observed in this rock, a semblance of brecciated structure, and following up its left bank for about a mile, winds to the right, and, between escarpments of calcareous sandstone, whose hori-

* A more modern marly limestone partially overlies it, as will be immediately noticed.

zontal strata alternate with others of coral limestone, ascends the rising ground upon which the large and populous village of Alhama is situated. Such are the appearances presented in traversing this basin along the line of road from Granada to Alhama, a distance of about 30 miles from NE. to SW.

2. *Neighbourhood of Alhama.*

Alhama stands upon the left bank of a rivulet of the same name, and at the bottom of a long cultivated slope to the latter, from the ridge of secondary nummulite limestone which forms the southern boundary of this portion of the basin. The horse-road from Granada to Malaga by Alhama passes over this ridge, between which and the coast it subsequently traverses the primary and transition chain stated to border the Mediterranean, reaching the latter near a town called Velez-Malaga. Consequently, in proceeding from Velez-Malaga to Alhama, the road descends the cultivated slope last alluded to, and in the latter part of the descent, a limestone composed of a congeries of coral remains is observed occasionally to make its appearance in broken discontinuous escarpments, partially covered, and often nearly surrounded by fine diluvium, which in great depth constitutes the general upper stratum and vegetable soil. Immediately before entering Alhama by this road, a similar limestone is again observed in thick horizontal strata, and, in different open spaces within the precincts of the village, horizontal strata of calcareous sandstone and fine conglomerates may be seen. The latter beds constitute, indeed, the foundation upon which it has been built, and immediately below the village form the high escarped banks which confine the stream bearing its name. Similar strata were noticed on the opposite bank, in the last part of the descent to the same stream in approaching Alhama by the Granada road, as well as in the short subsequent ascent to the former, alternating, in the latter instance, with others of coral limestone. This marine formation, first observable on the line of road sketched in the immediate vicinity of Alhama, rests upon secondary nummulite limestone, which fortunately comes to day in a few instances in this neighbourhood, and establishes this interesting fact.

An inspection of the physical appearances presented by this southern portion of the basin, shews that it has been broken through or furrowed in different places by currents descending from the primitive district to its south, and the streams now flowing through the consequent fissures, taking a north-westerly direction, finally terminate, before leaving its area, in the river Genil. These fissures, of which one of the boldest and most characteristic is seen close to Alhama, contracted in the vicinity of the mountains, subsequently expand into little valleys of denudation. In one of these, beginning to open out immediately below Alhama, the observations were made which belong to the section A; those referrible to B were partly made in the last mentioned fissure or ravine which confines the rivulet above Alhama, and partly in the neighbourhood of the villages of Arenas and Jayena.

A. The horse-road from Alhama to the town of Loja descends the little valley of denudation which commences near the former village, and is watered by the rivulet of the same name; and, at the distance of about two miles, crosses a small ravine * whose bed and banks are formed of secondary nummulite limestone. This rock is divided into strata from two inches to a foot thick, dipping at a small angle towards the W.NW., and is no doubt connected below with the great mass of the same limestone which constitutes the boundary of this part of the basin towards the south. These strata are succeeded in immediate superposition, on the left bank of the ravine, by a few strata of calcareous sandstone, identical with that observed at the entrance into Alhama by the Velez-Malaga road. In a subsequent short ascent no rock is seen, but it is crowned by a low escarpment of coral limestone in thick horizontal strata, bordering a little flat upon which a farm-house and a few cottages have been built. From this point the road begins to ascend a hill of considerable elevation, named El Majar de en Medio, which intervenes between the left bank of the rivulet of Alhama and the bounding ridge of secondary limestone towards the south.

The rising undulating surface presents a light soil, which, after rain, becomes what is termed *sticky*, the whole of it being under cultivation, and producing great crops of wheat and bar-

* This ravine terminates in the rivulet of Alhama, at about two miles distance from the point in it alluded to in the text.

ley. Continuing to ascend, numerous little shining pieces of laminar gypsum are observed, interspersed in this soil. The acclivity gradually becoming steeper, cultivation ceases, except here and there in small patches; the tract begins to assume a mountainous character, and the line of road inclining towards the left or south, approaches the confines of this eminence with the bounding ridge of the basin. Several escarpments, looking like perpendicular sections in a quarry, were observed along the higher part of the acclivity, and beyond these a long irregular low parapet, bordering and circulating around the summit of the hill. On approaching the former, they were found to originate in workings for gypsum, and to consist of a series of horizontal layers or strata of this mineral, accompanied by marl. These layers, or little strata, are from one to three inches thick, and the escarpments from twenty to forty feet high. The gypsum is of a laminar structure, and confusedly crystallized, several separate pieces of it being often joined together in all sorts of directions, and imbedded in an argillaceous marl, which seems to form about one-fourth of the mass of each layer or stratum. On reaching the summit of the hill, about a hundred yards beyond these quarries, the little escarpment which runs along its crest, was observed to be formed of thick horizontal strata of compact limestone, in which moulds of paludinæ are occasionally seen. It is of a whitish colour, frequently marked by little dendritic sprigs: its fracture compact and even, sometimes obscurely conchoidal. A considerable tract of table-land, where this rock is every now and then seen to come to day, and covered with a short herbage, underwood, and a few evergreen oaks, extends as far as the eye can reach, in the direction of Loja, and, towards the south, appears to abut against the higher ridge of secondary limestone, which, as before stated, bounds this portion of the basin.

In the ascent from the bed of the ravine to the summit of this hill, beds of four distinct characters have therefore been observed, viz. 1. The nummulite secondary limestone; 2. Strata of calcareous sandstone and coral limestone; 3. A powerful bed of gypsum; 4. Compact paludina limestone; and the horizontality* according to which they are arranged seems to

* The slight dip of the secondary nummulite limestone would conduct it under the tertiary strata of the hill.

put beyond doubt their respective superposition*. Facing the hill, whose geological structure I have attempted to sketch, there is a tract of high ground on the opposite or right bank of the rivulet, or Rio de Alhama, which is a continuation of the table-land along the summit of the ridge between the villages of Cacin and Alhama noticed in describing the line of road from Granada to Alhama.

In proceeding from the hill of El Majar de en Medio to this high ground, a ford was crossed in the rivulet, at a point about two miles *below* the mineral-baths of Alhama, which take their rise in an insulated mass of secondary nummulite † limestone, confining there for a short space its banks, and at about the same distance *above* the little village of Santa Cruz, situated upon the same stream. The valley here becomes more expanded, and a horizontal flat of some extent borders the right bank of the rivulet. A long cultivated slope succeeds ‡. At about two-thirds of the ascent, the compact limestone, with its usual paludinæ, makes its appearance in thick horizontal strata, and continues to manifest itself in low irregular escarpments to the summit of the hill. Here there is an extensive tract of level ground, varied by some undulations and hollows, and covered with short herbage, wild plants and shrubs, analogous, both in physical character and geological relations, to the eminence on the opposite side of the valley. During three hours which I was riding in various directions over this table-land tract, spread over with a scanty covering of vegetable soil, I constantly observed the compact limestone, and no other rock; but, at about the distance of three miles in an easterly direction, and towards the line of road from Cacin to Alhama, the shelly marly pla-

* The shelly marly planorbis limestone, observed to rest upon limestone 4, near the village of Cacin, and in the ridge between Cacin and Alhama, was not observed here.

† I believe these mineral waters take their origin in a red sandstone, upon which the secondary nummulite limestone rests.

‡ Although I did not observe any beds of gypsum here, I was assured by different peasants, that it is met with in several places, but not worked, as the neighbouring villages are supplied abundantly with this mineral, from the quarries noticed in the hill of El Major de en Medio, on the opposite side of the rivulet.

norbis limestone makes its appearance in the form of swelling undulations, which constitute some of the highest points in the ridge. It does not, however, extend equally over the surface of the compact limestone upon which it rests: from its friable nature it has been much affected by various external causes, and in many places has disappeared. It is in horizontal strata often several feet thick.

B. *Ravine above Alhama, and a Portion of the Basin to its south-east, in the neighbourhood of the Villages of Arenas and Jayena.*

The coral limestone seen immediately before entering Alhama by the Velez-Malaga road,—the little escarpments of calcareous sandstone and fine conglomerates of a similar base within the precincts of the village,—the alternating beds of the two, in the descent from the latter to the bridge, and the appearance of sandstone strata at the commencement of the succeeding ascent on the road to Granada, have been already mentioned; and it has also been stated that a part of the village extends along the left bank of the ravine, which confines the stream known by the same name, for about two miles above, and which opens out into a valley of denudation immediately below it.

This ravine affords the greatest facility for observing, and the finest example of this marine formation. Here the rivulet flows between perpendicular escarpments nearly two hundred feet high, which are entirely composed of the two rocks just alluded to, in horizontal alternating beds from three to nine feet thick. The limestone is made up of what appear to be small coral fragments, agglutinated together by a calcareous cement. A small fragment of a shell, an accidental little pebble, or a minute piece of schist, are rarely imbedded in its mass. It is tenacious, offering considerable resistance to the hammer, and is of a dull whitish colour, with a slight tinge, in some places approaching to red, in others to yellow. The fracture is uneven, coarsely and largely granular, exhibiting rarely the section of a coral branch, spines of echini converted into carbonate of lime, a few shining crystalline facettes, and some minute superficial cavities.

The sandstone is formed of small quartz grains, consolidated into a mass by an arenaceous calcareous cement. Remains, apparently of corals, are seen rarely imbedded in it; but different species of pectens, one of which is almost identical with a species found in the London clay, are sufficiently abundant. It is of a yellowish colour; and the fine conglomerates, as I have termed them, into which it sometimes passes, only differ from it by the size of the quartzose grains, and by the occasional interposition of small fragments of schist, and of some other rocks. The secondary subjacent limestone, noticed in the little ravine on the road to Loja, at the bottom of the hill of El Major de en Medio, is not visible here, the whole of the escarpment, from its base to its summit, being formed of the two varieties of rock just described, the coral limestone occupying the superior part of the section. It is in the interval between this and the bed of the ravine, that alternations of the two members of this formation are seen; and it is observable, that near the contact of the limestone with the sandstone strata, the former becomes gradually less calcareous, and appears to be an admixture of quartzose particles, to pass gradually into the latter. In one instance I observed a bed of loose unconsolidated quartzose sand, under upwards of one hundred feet of superior indurated strata. All the strata, in their natural position, are horizontal; but in the higher part of the escarpments, large masses of them are now and then seen variously inclined, probably by subsidence, and contribute powerfully to enhance the picturesque scenery of this fissure.

The road from Alhama to Arenas (de Alhama), proceeds for about one and a-half or two miles along the bed of this ravine, and, after leaving it, enters upon a narrow cultivated flat, contiguous to its right bank, and bordered, at a little distance on the left-hand side, by a low escarpment of coral limestone, from under which an insulated mass of older nummulite limestone protrudes and intersects the line of road, rising but a few feet above the general level of the ground. This is the second instance clearly presented in this neighbourhood of such superposition. After subsequently ascending some hilly ground where no rock appears, mica-slate of a reddish tinge, due to the decomposition of its numerous imbedded garnets, projects above the surface, in several little low groups, close to a spring of beautiful water called La Fuente de los Alamillos, and forms a considerable undulating tract, covered with vineyards, between this point, a village called Hator, and the high primary mountain of Tejeda, which now forms the southern boundary of the basin, at the distance of about three miles from the line of road. This elevated mountain, indeed, composed of white and light-blue crystalline limestone, constitutes the marked geographical limit of the basin towards the south, all the way from Alhama to Arenas, and the mica-slate, forming the low tract just alluded to along its base, *dips under it** ? and is again met with or reappears at the base of its opposite slope, and may thence be followed to the Mediterranean shore.

About half a mile before arriving at Arenas, an insulated mass of darkish-coloured earthy limestone, containing numerous shells of the genera Paludina, Lymnea, and Planorbis, was observed, in horizontal strata, and yielding on fracture a fetid odour. In the remaining part of the descent to the stream, on whose right bank Arenas is situated, no rock is seen, a whitish marl constituting the upper stratum.

This little stream, rising in the adjoining primitive district, and passing by the village of Hator, standing at the base of its northern slope, joins, below Arenas, another stream, which, at the distance of two or three miles towards the east, issues out of the same mountains. Between the two there is a low ridge which will be the immediate subject of consideration. Its length, from the base of the primitive district to Arenas, is about four miles; its medium breadth about three quarters of a mile, increasing a little as it approaches the former. It is composed principally of a lacustrine deposit; but in the vicinity of the primitive district, of a mass of gravel and conglomerate. Close to Arenas there is a small transversal ravine in this ridge, where the nature of the former is well exposed. The lower part of its banks is formed of alternating strata of earthy marly limestone, of a dirty whitish hue, and of thin layers of a similar substance, coloured blackish by a carbonaceous matter, and so

* This limestone may perhaps be considered as an immense bed in the mica-slate. I am, however, inclined to believe that it is of a subsequent date, and rests upon it.

charged with the latter in some places, as to pass into an imperfect lignite. With these layers, which may be followed for a considerable distance by the eye, until they successively become concealed by the intersection of the rising bed of the ravine, there is associated a remarkably fine white sand, formed of minute grains of transparent quartz; the layers are from one to two inches thick, of a leafy structure, and so extremely friable, that it is nearly impossible to detach an entire specimen, as it falls to pieces between the fingers. They are full of planorbes lying horizontally upon the surface of each successive leaf or plate of the layer; but the shells, although frequently retaining a nacreous lustre, are in a decomposing state, and rarely entire, so that every new exposed surface is studded with their fragments, or marked by their impressions.

The associated sand forms no regular stratum or continuous bed, but it is generally seen in more or less abundance, loosely attached to the surface of each layer. A bed of brown coal, of unknown depth, immediately succeeds in a descending series, and in its superior part, or that contiguous to the former, I also observed quartzose sand under similar circumstances. This brown coal is of a dullish-black colour, and in horizontal divisions, from one to four inches thick. The thinner ones, however, both superficially and in a cross fracture, sometimes exhibit a shining and even surface; but in the thicker strata or divisions, the fracture is uneven, and dull. On the surface of a specimen of the latter in my possession, taken from the superior part of the bed, there are innumerable fragments of planorbes. As it is in the lowest part of the banks of the ravine that this bed of brown coal begins to take a decided character, no means are afforded of examining the interior of the mass; and the workings undertaken here some years ago, under the idea that it was the real coal, by the proprietors of a sugar manufactory at Torroz, on the Mediterranean coast, are unfortunately obliterated.

The ravine in which the appearances just sketched may be seen, only penetrates the ridge for about two hundred yards; but as some strata of a similar nature are observed on the banks of the stream, on its opposite side, it appears probable that this bed occupies its whole breadth.

The superior part of the ridge consists of earthy marl and horizontal strata of soft marly limestone, which hardens on exposure to the atmosphere, and is used for building, alternating with others of a more sandy nature; and one stratum was observed of a hard compact sandstone, a foot thick. Other strata of the marly limestone intervening between the above and the bed of brown coal, are coloured by carbonaceous matter, and full of paludinæ.

There appears to be a direct analogy, with respect to organic remains, between this deposit and the superior marly limestone observed along the summit of the ridge between Cacin and Alhama. The carbonaceous matter in the former is of course of local occurrence.

In proceeding from Arenas up this ridge, to its confines with the primitive district, by the road which leads to the Puerto de Competa *, the first part of the ascent consists of earthy marl, with horizontal strata of the same substance, or between this and a coarse limestone, in an indurated state. I also observed some masses of fine quartzose sand, similar to that above noticed, but no appearance of the brown coal. The line of road crosses the ridge diagonally; near the mountainous district it becomes entirely formed of a mass of gravel, crowned at times by a thick stratum of reddish-coloured indurated conglomerate, and this deposit † is observed to extend for a considerable distance in the form of an inclined band, covered with a forest of pines, between the line of the primary rocks and that part of the basin under consideration between Arenas and Jayena.

The few remaining observations refer to this tract. The road from Arenas to Jayena crosses over the little ridge last alluded to, at a short distance above the point where the two streams, which may be said to bound it, unite, and descends to that whose banks were stated to exhibit a series of strata simi-

* This is the entrance into the primitive district, whence a mountain-road leads to the Mediterranean coast.

† Similar masses of gravel, but upon a much larger scale, are observed to form an extensive tract between the northern slope of the Samosierra mountains, to the north of Madrid, and a formation of compact limestone met with before arriving at Aranda del Duero, on the road from Madrid to Burgos. In both instances the gravel and conglomerate has been formed from the debris of the primitive rocks in the contiguous chains.

lar to those immediately overlying the bed of brown coal. Another stream escaping from the primitive districts towards the south, through a fissure called El Puerto Blanco, a few miles in an easterly direction is soon after crossed; between which and a fourth stream passing by the villages of Jayena and Fornes, there is an undulating marly tract partially under cultivation, and rising into a low ridge, in part of its area crowned by a few strata of conglomerate. All these streams last mentioned unite in one a few miles towards the north-west, and form the rivulet crossed at Cacin, on the road from Granada to Alhama. Descending the slope from this little tract to the stream last alluded to, a long slip of ground is perceived to border its right bank, immediately beyond which the country begins to rise, and subsequently takes an elevated table-land form, stretching northwards towards Agron, a village on the road from Arenas to Granada. Horizontal beds of gypsum are observed along the first part of the ascent, and a low escarpment, which I had not time to examine, but which probably is formed of the compact paludina limestone, borders its summit. Following this stream upwards to Jayena, several low escarpments along its banks exhibit horizontal strata of a semi-indurated whitish marly limestone, and the slip of land just noticed opens out into a richly cultivated little valley, in the immediate vicinity of this neat and chearful village.

In the low ridge, composed of horizontal strata, of whitish soft marly limestone, in places full of paludinæ, which borders this narrow valley towards the north, near and above Jayena, there is a ravine close to the latter village, in whose banks a bed of brown * coal has lately been discovered.

The valley extends three or four miles above Jayena, presenting in every little escarpment the same marly limestone. Here I terminated my excursion, and traversing the primitive chain which confines it towards the south, proceeded by a mountain road over the magnificent pass called Las Vueltas †, or

* The scarcity of fuel in the mining district along the Southern Mediterranean coast of Spain, and the prohibition of English coal, has induced a great commercial and mining house in Malaga, to make excavations here, in order to employ it as a substitute.

† The fine alpine scenery here, and along the slope of a high mountain-

Puerto del Rey, to Almunecar on the Mediterranean coast. (See section 13.)

From the above slight and most imperfect sketch of the basins of Baza and Alhama, it appears that a deposit of gypsiferous marl, with a superjacent bed of compact paludina limestone are common to each of them; but that the latter basin is distinguished from the former, by a superior bed of shelly limestone, in which the planorbis first makes its appearance,—by two deposits of brown coal in the neighbourhood of Arenas and Jayena,—and by a tertiary marine formation, consisting of alternating beds of calcareous sandstone and coral limestone, which intervenes between the gypsiferous marl and the secondary nummulite limestone.

The tertiary and lacustrine beds in each of these two basins are in a horizontal position, and do not therefore appear to have been disturbed by any causes similar to those which have elevated the older rocks, upon whose inclined strata they have been deposited.

But causes of a different nature have, either gradually and in the progress of ages, or with sudden and irresistible fury, swept over them with no unsparing hand, carried away, in the basin of Baza, the greatest part of the superior deposite, and left extensive vestiges of destruction upon its western and eastern flanks. Nor are the effects less conspicuous in the basin of Alhama.

At the present day, streams of inconsiderable magnitude flow quietly along their respective areas; and, instead of directing their course to the nearer Mediterranean, from which they are intercepted by the elevated chain which borders its shores, descend the great hydrographical valley of the Guadalquiver, and join the waters of this river, which terminates in the Atlantic Ocean.

Such, I believe, are the conclusions that may be drawn from observations confined to certain portions of the areas I have assigned to these two basins. A detailed and scientific examina-

ridge near El Convento de los Nieves, about two miles from a village called El Borgo de Ronda, nine leagues distant from Malaga, towards the north-west, is worthy of the pencil of a Salvator Rosa.

tion of their whole surface will, no doubt, bring to light many new and interesting facts.

Mr Sowerby had the goodness to name the following shells:—

Basin of Baza.

Paludinæ in superior compact limestone. Cypris in gypsiferous marl.

Basin of Alhama.

1. Planorbis rotundatus. 2. Planorbis rotundatus vel planulatus. 3. Planorbis nova species anfractibus numerosis compressis. 4. Bulimus pusillus of Brard; Paludina pusilla of Deshayes. 5. Paludina Desmarestii. 6. Paludina pyramidalis. 7. Ancylus. 8. Cypris. 9. Unknown univalve. Bulimus decollatus? 10. Lymnea. These are found in the compact and superior shelly limestone beds. 11. Pecten reconditus? like that at Hordwell and in London clay. 12. Fragments of Corals and spines of Echini. These are found in the marine bed, composed of alternating strata of calcareous sandstone and coral limestone, which rest upon secondary nummulite limestone.

Basin of Teruel.

1. Planorbis rotundatus. 2. Lymnea pyramidalis.

Vestiges of Tertiary and Lacustrine Beds, in the South and other Parts of Spain.

1. In the neighbourhood of a village called Partaloba, about eight miles distant from the transition limestone mountains of Oria, which partially bound, towards the east, the basin of Baza, a compact vesicular limestone, of a whitish-grey colour, and containing a few shells which appear to be of fresh-water origin, is quarried. It is in thick strata, and forms an excellent building stone.

2. Near Montesa*, on the road from Almanza† to Valencia, a low hill has been cut through, composed of thin fissil strata of a limestone identical in colour and fracture to the compact paludina limestone near Alhama, and containing numerous moulds and casts of lymneæ and paludinæ.

3. On leaving Albacetè, a town on the royal road from Valencia to Madrid, for the capital of Spain, a continued ascent of several miles, where no rock comes to day, leads to a high

* Montesa gives its name to one of the four military orders of Spain.

† Almanza, celebrated for the battle won by the Duke of Berwick, in favour of Philip, during the Spanish War of Succession.

plateau, which belongs, in physical geography, to the elevated plain of La Mancha. The upper stratum here consists of a bed of reddish gravel, probably of diluvian origin, which conceals the subjacent limestone; the latter, however, is well displayed in a quarry near, but before arriving at, the village of La Gineta. It is of a compact texture, somewhat vesicular, of a whitish-grey colour, and contains a few paludinæ.

From this point to Ocana, nine leagues from Madrid, the *plateau* maintains nearly the same general level, with occasional undulations, with the exception of a narrow low ridge of secondary (?) limestone near the village of La Mota, and an insulated, outlying hill of red sandstone near a village called Molar *, a name probably derived from the grinding-stones which the latter rock usually produces. With these two exceptions, no rock is seen *in situ* from La Gineta to Ocana. The superior stratum is almost universally of a marly or gravelly nature; but now and then a low eminence, or little hillock of puddingstone, or a few thin discontinuous strata, of an earthy whitish marly limestone, are observed by the side of the road. In passing through the village of Roda, I remarked that several of the houses were built of a compact whitish-grey vesicular limestone, which is, no doubt, met with in the immediate neighbourhood, as it would be a rare occurrence in this part of the country to bring such materials from any distant point.

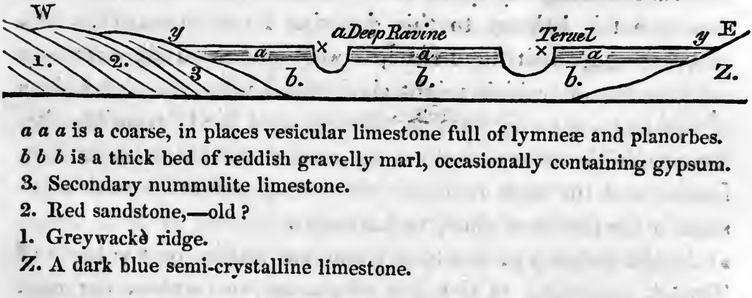
At Ocana, which may be considered as the northern termination of the *plateau* of La Mancha on this line of road, a similar limestone, in the form of an irregular low escarpment, borders the crust of the long slope from this elevated plain to the river Tagus; and in the descent to the latter, a powerful bed of gypsum is observed in horizontal strata, accompanied by varying proportions of marl. Between the Tagus and the river Jarama, which enters the former a little below Aranjuez, the road to Madrid passes over a level tract, occupied by the plantations, gardens, and pleasure grounds, belonging to the royal palace at Aranjuez,—and then, crossing the latter river by a handsome bridge, called Puenté de la Reyna, and traversing a little flat on the opposite or right bank, ascends a considerable

* Piedra de Molar, is the Spanish expression for a grinding-stone.

hill, in the lower part of which gypsum is again observed. It then enters upon a high plateau-formed district, corresponding in physical character to that which constitutes the plain of La Mancha to the south of the Tagus, which extends northwards to the base of the Guadarama Mountains. Madrid is situated in this district, at the distance of seven leagues from Aranjuez. Between the summit of the last ascent and a village named Valdemoro, several low escarpments of gypsiferous marl strata, in a horizontal position, are seen near the road; but the general superstratum of this tract is of an argillaceous marly character. In the remaining distance to Madrid, or rather to the banks of the Manzanares, no gypsum was observed; but the road has in places been cut through a little hillock or low eminence, and the consequent escarpments exhibit a few thin strata of a whitish compact limestone, which, for short spaces, occasionally assumes a siliceous character, where its surface is sometimes mamillonated by concentric spheres of chalcedony, minute veins of which also penetrate its mass. These strata, often marked by blackish dendritic sprigs or stars, alternate with earthy layers of friable marl. On each side of the road there is an open undulating cultivated plain, whose upper stratum is composed of fine diluvial detritus, amongst which innumerable siliceous semi-opaline fragments are observed, identical with several varieties of a similar substance imbedded in the well-known hill of magnesite near Vallejas, about 2 miles E.SE. from Madrid. From this ground there is a long gradual descent to the Manzanares; and the right bank of this stream exhibits an extensive mass of gypsiferous marl, in horizontal laminæ or little strata, the gypsum being generally of a laminar, but in some places of a fibrous, structure. The hill of *magnesite*, or carbonate of magnesia, at Vallejas, rests upon this bed of gypsum. In the immediate neighbourhood of Madrid, a compact vesicular whitish limestone is quarried, whose mineralogical character would seem to identify it with that to which allusion has been so frequently made. It would be interesting to ascertain whether or no it contains fresh-water shells, and overlies the gypsum formation along the bank of the Manzanares. The Professor of Geology and Mineralogy to the Royal Museum, in Madrid, had the goodness to shew me a fragment of the *magnesite rock*, with a beautiful impression or mould of a large planorbis: now, as this univalve is not met with in the compact limestone, but first makes its appearance in the coarse marly limestone, almost entirely composed of comminuted shells of this genus, which overlies the former near Alhama, and is the superior rock seen in that basin, this circumstance leads to the conclusion, that the *magnesite* of Ballejas, like the superior marly limestone near Alhama, is of lacustrine origin, and amongst the most modern rocks in Spain,—as a similar one has already been shewn to be so in France, by Messrs Brongniart, Marcel de Serres, and other writers.

4. The last instance of a lacustrine formation which I have had an opportunity of meeting with in Spain, is presented over an extensive tract in the neighbourhood of Teruel, a town upon the frontier of Arragon, towards the province of Valencia, and upon the road from the city of Valencia to Zaragoza. The annexed rough sketch may give a general idea of this lacustrine deposite, and of the older rocks which bound it towards the east and west.

Lacustrine Basin of Teruel, Province of Arragon.



a a a is a coarse, in places vesicular limestone full of lymneæ and planorbes.
b b b is a thick bed of reddish gravelly marl, occasionally containing gypsum.
3. Secondary nummulite limestone.
2. Red sandstone,—old?
1. Greywackè ridge.
Z. A dark blue semi-crystalline limestone.

The superior fresh-water limestone *a a a*, would appear to have originally prevailed, as represented in the sketch, over the whole width of the basin from *y* to *y*, a distance of about 16 miles; but causes, whose violence or prolonged duration is manifest in the valleys of denudation and deep ravines which actually intersect this area, have swept it away over the greater portion of the basin. Where it remains sufficiently entire, it forms patchs of table-land, and the slopes from these to adjoining fissures exhibit an irregular talus of the subjacent marly deposite; and where its horizontal strata have been removed, the surface of the ground presents an earthy calcareous mass, containing the two cited univalves in great abundance. The latter may be collected in any quantity in the earthy mass of the hill, upon which a hermita or little chapel stands, about half a mile from Teruel, beyond the arcos or aqueduct, as also in the higher part of the first ascent on the road from Teruel to a village called Campillo; and, on the summit of both these hills, they are found imbedded in thin strata of the limestone. The planorbis is the most abundant shell, and, as well as the lymnea, of a larger size than what were observed in the basin of Alhama. They are, generally speaking, in the form of casts or moulds, although a part of the remaining whitened shell is usually observable.

This limestone forms an excellent and most durable building stone, as is well exemplified in the beautiful arcos or aqueduct at Teruel, of whose construction no record exists.

In the subjacent bed of marl, which is more or less argillaceous, I observed, on approaching Teruel, by the Valencia road, veins of laminar gypsum, and was informed that this mineral is extensively quarried in the neighbourhood, but whether or not it belongs to this deposite, I cannot certify. During my short visit to Teruel, I was unable to discover any organic remains which might elucidate the geological relations of this bed. The gypsum accompanying it, and its position below the fresh-water limestone *a a a*, and above the secondary limestone 3, present analogies with the gypsiferous marl deposites in the basins of Baza and Alhama.

At the points *y y*, the transversal extremities of the basin of Teruel, according to the line of the section sketch, the road crosses over two bands, which, from the innumerable rounded fragments of older rocks spread over the surface, as well as from the lateral position of the former with respect to the basin, would seem to indicate the action of some great body of water which has swept along this area from north to south.

It was in the first week of May 1828, I visited Teruel. The summits of the higher hills in the elevated mountain tract, designated Z, were covered with snow, as well as many of those in the transition ridge 1; beyond the tertiary basin towards the west, and until the sun was much above the horizon, the cold was considerable. From this circumstance, and the continual ascent from Murviedro, upon the eastern mediterranean coast of Spain, to a point in the tract *Z*, called El Puerto, about three leagues beyond Segorvè, on the line of road from Valencia to Teruel, it appears evident that this lacustrine deposite has taken place at a very considerable elevation above the level of the sea; and the same remark may be made with respect to those in the vicinity of Baza and Alhama, as well as the compact limestone observed near La Gineta and Ocāna in La Mancha: nor shall I be far from the truth in calculating the surface of the superior beds in the respective basins of Teruel, Alhama, and Baza, at about 2000 feet above the level of the sea. The ground near La Gineta and Ocāna is still more elevated.

It has been stated, that within the area of each of the lacustrine basins near Baza and Alhama, springs or streams impregnated with muriate of soda existed, the former being called Las Salinas de Vacor, the latter Las Salinas de Malà. Contiguous to the gypsum tract near Aranjuez, which, together with the superjacent compact limestone seen at Ocāna, are, from identity in composition and geological position, *presumed* to be lacustrine like the same two formations near Baza and Alhama, sulphate of soda has been discovered in sufficient abundance to be employed advantageously in the arts *; and a couple of miles higher up the same bank of the Tagus, muriate of soda, in the form of rock-salt, is met with at Villa Rubia, a village whose name is well known to mineralogists as the locality of the glauberite.

The analogies thus pointed out, and the real geological relations of these deposites of salt, I leave to future observers, who may perhaps discover that the high elevation of the *plateau* of La Mancha is partly owing to a thick and extensive formation of tertiary beds.

* This sulphate of soda was first discovered by a Spanish gentleman of the name of Rodas, who, in consequence, erected a large manufactory at Aranjuez, where it is converted into a carbonate, and sold to soap-makers as a substitute for barilla.

On the Development of the Vascular System in the Fœtus of Vertebrated Animals. Part II. By Allen Thomson, M. D. late President of the Royal Medical Society. Communicated by the Author. *(Continued from former volume, p. 327.)*

Having in the former part of this essay considered the mode of formation of the Heart in the different orders of vertebrated animals, I shall now give some account of that of the other parts of the vascular system; viz. of the Bloodvessels of the body.

There seem to be two modes principally in which bloodvessels are developed; the one, by isolated points and vessels, has been already alluded to, in the account given of the commencement of the circulation, as it occurs on the vascular area of the yolk; the other, taking place after the commencement of the circulation, by the prolongation of loops or folds from vessels already formed, is most easily seen on the transparent parts of the Batrachian reptiles.

The sac of the yolk, or covering which the yolk receives from the layers of the germinal membrane, is the part on which, in all vertebrated animals, the blood and vessels appear to originate, and it is the only part in which, in healthy animals, the formation of bloodvessels has been observed to take place independently of the heart or general circulation. During the development of the vascular area (to the detail of which it is now unnecessary to recur), no difference has as yet been observed between the mode of the formation of arteries and veins. The blood appears to circulate sooner in the veins than in the arteries of the area, but, in the early stages of development, these vessels are to be distinguished from one another only by their distribution, and the direction of the currents of blood in them. About the fourth or fifth day of incubation, the coats of the arteries begin to appear thicker than those of the veins, and very soon the external appearance of these vessels affords a character sufficiently distinctive. As far as has been ascertained, there does not appear to be any immediate connexion between the formation of vessels in the area, and that of the heart itself: these processes seem, for a time at first, to go on simultaneously, but independently of one another; and, indeed, the origin of the heart may not inaptly be compared to that of some of the larger bloodvessels. Even when that organ begins to move, no blood enters it from the area: according to Baer, its motion is undulating for a few hours, until it sucks, from the veins immediately adjacent, a portion of their contents, and soon, by a regular contraction of its parietes, propels the blood through its anterior part and the arteries connected with it.

At the same time that the vascular area is formed, some vessels are likewise developed in the body of the embryo, in which also the blood and vessels containing it appear to be simultaneously produced. But after the circulation has commenced, the second process to which I have alluded, viz. the prolongation of loops from vessels already existing, seems to be more frequently resorted to for the development of new vessels in the fœtus.

This process has been described by Spallanzani *, Fontana †, and Döllinger ‡, as it occurs in the finny tail and external gills of the common frog and water newt. In these animals, the course of the blood is at first very simple. In the early stages of development, there is no capillary network on the tail; but an arterial vessel, continued from the descending aorta, runs below the caudal vertebræ to the end of the tail, where it joins at an acute angle with a returning vein, which, in the abdomen, becomes the vena cava inferior. At a later period, it is well known that the tail of these animals is covered by a network of minute vessels, which communicate with the primary artery and vein. Through this network the blood is spread over the whole surface of the tail. The development of these vessels has been shewn to be owing, not to their formation separately in the parenchyma of the tail, but to the prolongation of communicating vessels formed between the primary trunks. The communicating branches at first pass directly from the artery to the vein, but in the progress of development I have observed them to become gradually longer, and extend themselves from the middle to the lateral expanded parts of the tail: other loops are formed in succession from the newly generated vessels, and new ones again from them, till, in the course of ten or more

* Experiments on the Circulation of the Blood, &c.

† Reil's Archiv für die Physiologie, B. ii. S 480.

‡ Denkschriften der Königl. Akad. München. B. vii.

days, the whole of the finny part of the tail is covered by beautiful and minute arteries and veins. The loop of vessel when short and newly formed, has at first more the appearance of artery than vein, as the blood passes through it in jerks: as the loop elongates, however, and new branches proceed from it, the blood moves in jerks only in that part of the loop which communicates with the arterial trunk, while in the part connected with the returning vein, the motion of the stream of blood becomes uniform.

Rusconi * has shewn very beautifully, that vessels are thus looped out during the development of the gills of the aquatic salamander. I find that nearly the same appearances present themselves in the gills of the frog, as well as in the extremities of the salamander. The anterior extremities of the salamander, when they first begin to sprout, form two small tubercles situated behind the head, altogether destitute of circulating blood. Shortly after the appearance of these tubercles, a single vessel is seen winding round their extremities, which returns to the body without giving off any branches. The parenchyma of each of the toes, as it buds out from the end of the limb, receives a small loop from the original vessel. Communicating branches are likewise thrown across at the joints, and, as the limb becomes larger, numerous capillary vessels are formed in the same way as the primitive trunks.

Spallanzani, and some other observers, have noticed similar appearances in the extremities of the chick, when they begin to be formed; and the same may be seen in those of the rabbit, and of some other mammiferous animals; from which there appears every reason to believe that, after the circulation of the blood has commenced, the development of new vessels from those already formed, takes place principally by means of loops in Warm as well as in Cold blooded animals.

I ought now, in conformity with the plan previously laid down, to proceed to treat of the development of the individual parts of the vascular system in vertebrated animals; but it must appear obvious, that a detailed account of the development of

* Amours des Salamandres Aquatiques, et développement, &c. See Plate II. Figs. 8, 9, 10, 13, H h.

all, or even of the more important bloodvessels of the body, besides being too extensive a subject for our present limits, would prove uninteresting from the want of connexion existing between the facts already ascertained. I shall therefore confine myself for the present to one branch of the subject only, viz. the Development of the Bloodvessels more immediately connected with Respiration in the fœtal or adult animal. This branch of the subject, besides being the most nearly allied to that treated of in the first part of the essay, is rendered one of the most interesting to comparative anatomists, not only by the diversity of the form and by the number of the organs which appear to carry on the respiratory function in the fœtus of vertebrated animals, but also by the singular analogies in the structure of these animals which the study of the development of their respiratory organs points out both in their transitory and permanent condition.

The principal organs which appear to perform a respiratory function in the fœtus, or which, being formed before birth, are destined for the respiration of the adult animal, may be enumerated in the following order, being that in which they succeed one another, either in individual animals, or in the different orders of the class Vertebrata. 1. The sac of the Yolk; 2. The External Gills; 3. The Internal Gills; 4. The Allantois; 5. The Placenta; 6. The Lungs *.

* Some of these, as well as other parts of the ovum, have received so many different names, from the various authors who have described them, that it appears necessary to anticipate a little, and to give a few of the synonymes by which they are generally known in the different orders of vertebrated animals.

1. The sac of the yolk is generally known by this name in Fishes, Reptiles, and Birds. We have only in these animals to guard against confounding the *sac of the yolk* or covering given to this part by the layers of the germinal membrane, with the *proper envelope of the yolk* which exists before development commences, and encloses it while in the ovarium. In Mammalia, this part is most frequently called the Umbilical Vesicle, and sometimes the tunica erythroides. The distinctive character of the sac of the yolk is, that it remains connected or communicating with the intestine during some period of fœtal life, and has mesenteric arteries or veins, or both, ramified on its surface.

2. The Allantois, (a name derived originally from the vesicular membrane of mammalia) does not exist in the fœtus of aquatic animals, such as that of fishes and batrachia. In adult batrachia it forms the urinary bladder,

In proceeding to describe these organs, I shall endeavour to shew the manner in which they contribute to perform the function of respiration in each of the four orders of vertebrated animals, beginning with fishes, in which they appear to be simplest; and I shall confine myself principally to the relation of those facts which have been most lately ascertained, and which appear to establish most clearly the analogy existing between the organs under consideration.

It is from the study of the structure of the respiratory organs, and of the arteries distributed upon them, that the chief part of our knowledge regarding the mode in which the function of respiration is performed by them has been obtained, as little or no direct or strictly physiological evidence has hitherto been procured from the observation of their mode of action. The description of these organs indeed might be considered as a subject merely anatomical, were it not that in observing their development during fœtal life, their variation in size, and alteration in form at different periods, and the changes in the distribution of the vessels supplying them with blood, we are enabled to perceive certain ends to which these changes of structure are directed, and thus acquire some insight into the mode of operation of each of them.

It is now well known that the constant presence of oxygen in some form or other is absolutely necessary for the development of the embryo of all animals. The evolution of those rudimentary parts even, the formation of which precedes that of the

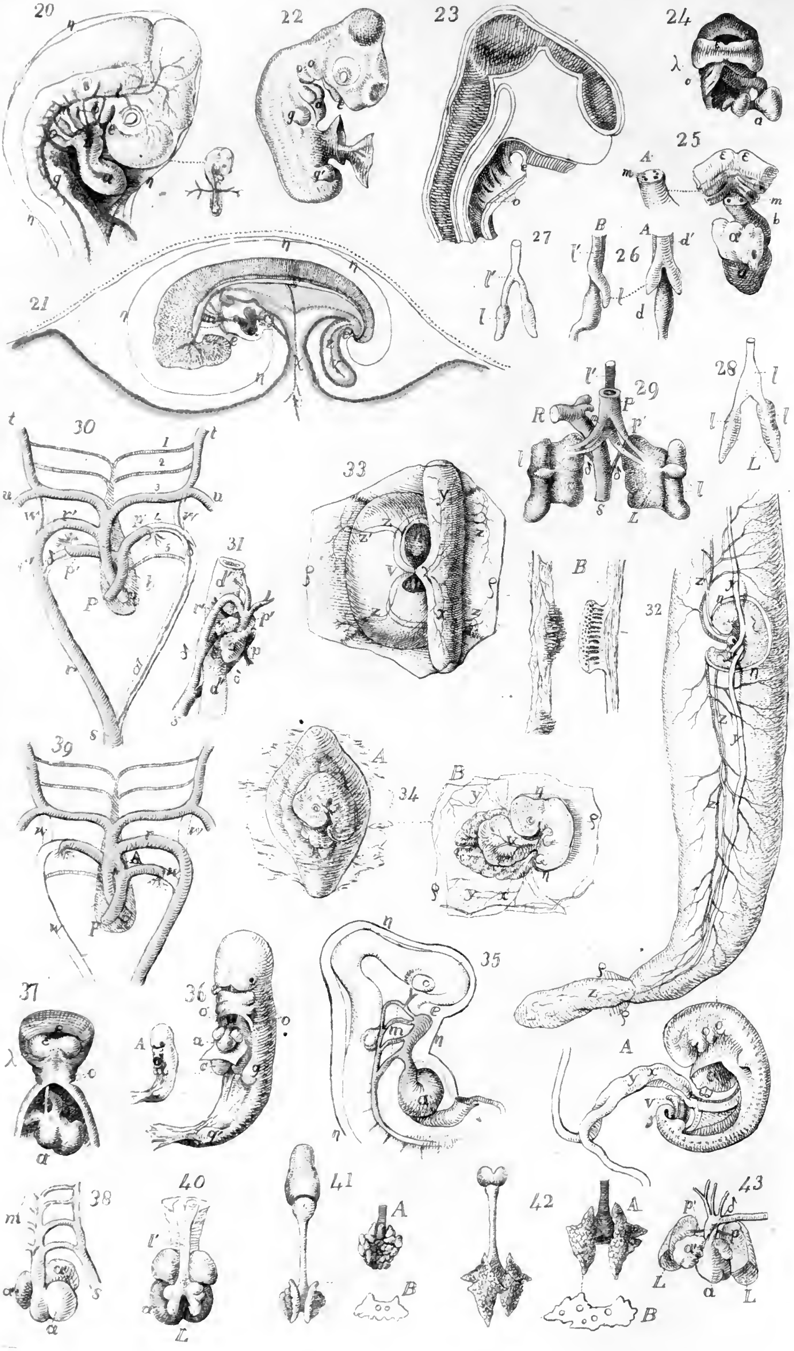
as well as in the tortoise. It is called Chorion by Emmert in the lizard, and by Pander in the bird; Umbilical vesicle by Haller in the bird, in which he was the first to shew its connection with the funis of the urachus. In Mammalia it has been called Endochorion, from its lining the chorion. This part is always formed by the expansion of the cloacal part of the intestine, and carries upon it the ramifications of the umbilical arteries and veins.

3. The internal gills are those formed in the course of the branchial plates or hoops which surround the pharynx.

4. The external gills are appendages of the foregoing, connected generally with the *outer* part of the branchial plates, and receiving a covering from the integuments.

5. The Amnios, a covering proper to the fœtus, connected with its integuments, and formed by a reflection of the serous layers of the germinal membrane.

6. The Chorion, the external envelope of the whole ovum.



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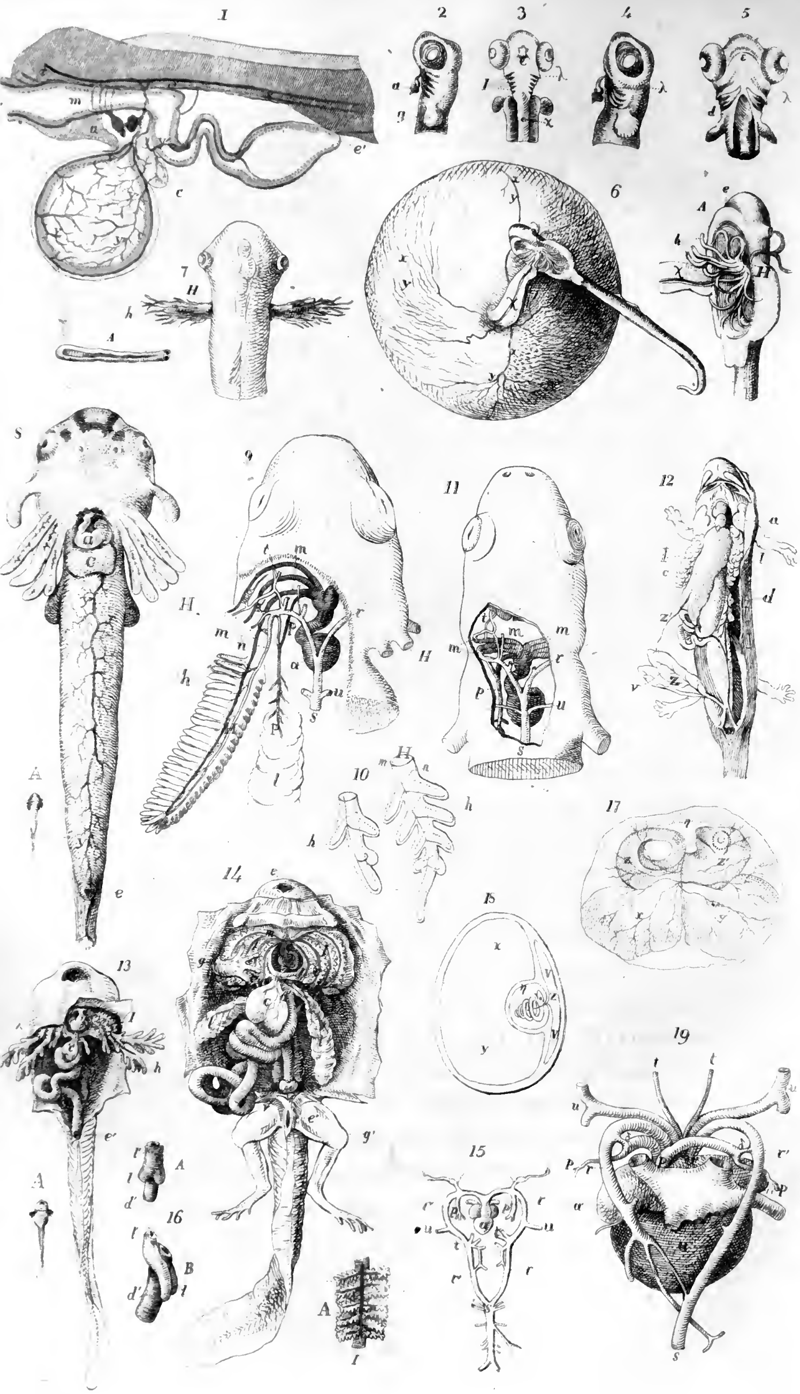

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blood, is almost immediately put a stop to by the removal of oxygen from the medium in which they are placed, before any particular part of the embryo is formed upon which the changes of respiration are afterwards more immediately produced. In the early stages of development, then, there appears to be what may be called a General or Interstitial Respiration *, or a change essential to life, produced by oxygen in all the substance of the embryo, or of its accessory parts, which, as the fœtus is more perfectly formed, takes place in particular organs only. As soon as a peculiar nutritive fluid, and a central propelling organ, are produced, this fluid is exposed on the expanded surface of the yolk, to the influence of the respiratory medium, either directly, or through the coverings of the ovum.

Development of the Respiratory Organs in the Fœtus of Fishes.

The sac of the yolk, the principal respiratory organ of the fœtus of fishes, differs considerably in its relations in the Osseous and Cartilaginous tribes.

In the fœtus of osseous fishes, as in that of the Blennius viviparus, described by Rathke † and Forchhammer ‡, the yolk, after it has received a covering from the expanded layers of the germinal membrane, hangs like a loose bag from the abdomen, and is connected by a narrow opening with the *anterior* part of the intestine. The vascular network spread over this covering of the yolk at a later period, as has previously been remarked, is formed entirely of veins in osseous fishes. A branch of the mesenteric veins (Pl. III. Fig. 1, *y'*) running along the back part of the abdomen, dips down to join the yolk at the place where this sac is connected with the intestine; this vein is divided into numerous minute ramifications on the back part of the yolk, and its capillary vessels unite below with those of another vein occupying the anterior side (*y y*), and conveying the blood

* See Geoff. St Hilaire on this subject, in the *Memoires du Museum*, tom. x.

† Geschichte des Embryo der Fische, in Burdach's Physiol. B. 2. S. 201.

‡ De Blennii Vivipari formatione et evolutione. Kiliæ, 1819.

which traverses the surface of the yolk to the vena cava, and thence to the auricle of the heart (a').

The liver, which in the early stages of development of all vertebrated animals appears to be intimately connected with the veins of the yolk, is formed in osseous fishes from a mass of granular substance (c) deposited in the hollow between the yolk and back part of the intestine. This mass, as it increases in size, is collected round the trunk of the vein distributed on the posterior surface of the yolk, and is gradually supplied with vessels formed by the subdivision of the main trunk of the vein. As the liver becomes larger, and receives arterial vessels from the cœliac trunk, the sac of the yolk is diminished in bulk, and the blood is not so uniformly distributed over its surface as before; the general capillary network being less supplied with blood, two or three of its vessels become dilated, and convey the greater part of the blood, which previously was spread over the surface of the yolk, directly from the liver to the heart. At last, when the yolk is much diminished in size, only one of these vessels remains, becoming the hepatic vein.

The envelope of the ovum of osseous fishes is generally so thin, that, from the first formation of the blood, the changes induced by the surrounding water are not materially impeded. When the fœtus, or little fish, bursts its covering, and escapes from the ovum, it swims about in the water, with the yolk, proportionally very large, hanging from its abdomen, and the blood is then more directly exposed to the current of water *. Towards the latter end of fœtal life, the yolk, while still of a considerable size, is in some fishes enclosed in the abdomen, and probably serves for some time to nourish the animal, while in others its substance is almost entirely absorbed before its enclosure.

In some of the larger cartilaginous fishes, on the other hand, as the Rays and Sharks, the sac of the yolk is connected with the *posterior* part of the intestine, and arterial as well as venous bloodvessels are distributed on the vascular area covering its surface (Fig. 6. of the Skate). The vessel ramified on the yolk appears to be a branch of the cœliac artery. The vein formed

* See account of the Spawning of Salmon, &c. by Daniel Ellis, Esq. in vol. iv. of this Journal.

by the union of the capillary vessels of this artery, conveys the blood which passes over the yolk to the liver; so that the distribution of the omphalo-mesenteric vessels in the fœtus of these fishes resembles that in lizards, birds, and mammalia.

As most of the fishes of this tribe are more or less ovo-viviparous, or retain their ova in the body during a longer or shorter period after development begins, the blood of the fœtus must be made to undergo respiratory changes through the medium of the fluids and membranes with which it is surrounded in the oviduct. The very vascular membrane lining the oviducts in some species of sharks which retain their ova during the whole of development, is destined, without doubt, for the aëration of the fluid surrounding the fœtus; and, according to Sir E. Home*, it would appear that the effect of this vascular membrane is increased by the entrance of sea-water into the oviduct. The apertures into the cavity of the peritoneum of these animals may also allow the water to come into contact with the oviduct; and, in some of them, which retain their ova for a short time only after development begins, apertures are found in the angles of the horny covering of the egg, through which a current of water is permitted to pass.

The yolk sac, so far as has yet been ascertained, is the only fœtal respiratory organ in osseous fishes; while the blood continues to be exposed to the influence of the water on its surface, the Gills or respiratory organs of the adult become developed. According to Rathke, the rudiments of the gills may be perceived in the embryo of the Blennius some little time after the circulation of the blood has commenced. These organs appear at first to be formed of five pairs of narrow plates, situated transversely on the lower side of the pharynx behind the mouth. These plates, of which the four posterior only become developed to form the perfect branchial hoops of this and other osseous fishes, are at first composed of the same dense gelatinous substance as the rest of the embryo, and do not exhibit any traces of vascularity. The same author has shewn, that the branchial arteries begin to be formed soon after the appearance of the rudimentary hoops, by the subdivision of the arterial vessel rising from the bulb of the aorta (Fig. 1, *b'*), on the lower part of the

* See an interesting paper in Phil. Trans. 1810.

pharynx. At first, this vessel divides itself only into two branches situated immediately behind the mouth, which, passing round the pharynx, reunite with one another on its upper part, below the vertebral column, to form the descending aorta. Shortly afterwards, a farther subdivision of the aorta takes place, by which four new vascular branches (*m*) are formed on each side of the pharynx, behind the one which appeared first, and leading from the ascending to the descending trunks of the aorta. These vessels, the primitive branchial arteries, are at first nearly of a uniform diameter, and do not divide into any branches in their course round the pharynx. Each artery runs along one of the branchial plates or hoops, (Fig. 2, I).

As development proceeds, four transverse clefts, the commencing branchial apertures, appear between the branchial hoops on the lower and lateral parts of the pharynx (Figs. 2 and 3, *o*). The four posterior hoops become stronger, more cartilaginous, and project farther from the side of the œsophagus, and, at the same time, little leaflets or tubercles, the rudiments of those which afterwards form the comb-like fringe of the gill, begin to be formed on their external sides. Each of these leaflets, soon after its first appearance, is furnished by the large vessel of the hoop with a little artery and vein, probably formed in the same manner as the vessels of the tail and gills of the salamander already alluded to. The number and size of the leaflets gradually augment, and, at the same time, each of the vascular arches is farther subdivided, till at last, when the structure of the gill is perfected, instead of the single arterial vessel, which at first winds round each hoop, there are formed a branchial artery and vein, the capillary vessels of which join by a multitude of minute ramifications on the surface of each of the leaflets. It has thus been shown by Rathke, that the branchial vein is originally a continuation of the trunk of the branchial artery. While those changes are taking place, the anterior vascular arch on each side, not contributing, like the posterior, to form the vessels of the gills, gives off an arterial branch (Fig. 1, *t*) at its anterior and convex part, which rises to the head, and corresponds with the carotid artery of higher animals. This vessel now no longer communicates with the ascending aorta, but is supplied with blood by the posterior part of the arch which joins the first pair of branchial veins at the place where the root of the aorta begins.

The anterior branchial plate, or that situated between the mouth and the foremost branchial apertures (Figs. 2, 3, λ) instead of being covered by the fringe of leaflets proper to the gills, projects farther backwards in the neck, and begins to overlap the branchial plates posterior to it (Fig. 4, 5 λ). According to Rathke, the anterior part of this plate forms the lower jaw; the posterior part, continuing to extend itself backwards, forms the opercular covering of the gills.

The branchiæ of the Rays and Sharks, again, consist of five pairs of double branchial plates, from the edges of which rows of leaflets are suspended; but, so far as I know, the mode in which they become developed has not been observed. It would be interesting to know in what manner the opercular fold and openings of the gills are formed in these animals, as the smallness of the lower jaw and the absence of the lateral processes of the lingual bone, seem to indicate that only five branchial plates originally exist in the fœtus, and that all of them become developed in the formation of the branchiæ of the adult animal.

The fœtus of cartilaginous fishes besides possessing a yolk-sac, in the vessels of which a large quantity of blood is spread out, are provided, during a considerable period of their fœtal life, with other organs, by means of which the aëration of their blood is promoted. The External Gills or branchial appendages were known to the late Dr Monro *, and are described as such by him in the skate, (see Fig. 6, A. H). The connection of these appendages with the hoops of the internal gills, was, however, first shewn by Dr Macartney of Dublin in the fœtus of the shark. They consist, according to this anatomist, of five bundles of tender filaments hanging from each side of the neck. These bundles appear to arise from the external integuments, but are really attached to the internal gills on the inner side of the branchial apertures †.

In some beautiful specimens of the external gills of the Squalus Catulus and S. maximus, which I had lately an opportunity of seeing in the Museum of the College of Surgeons, Lon-

* Monro on Fishes, plate XIV. † Journal de Physique, Fevrier 1818.

don, collected by Sir E. Home and Mr Clift (see sketch, Fig. 7)., I could easily perceive that each of the filaments of which the five bundles were composed consisted of a single fold or loop of vessel, covered by a thin membranous layer prolonged from the integuments. (Fig. 7, A.)

Development of the Respiratory Organs in the Fœtus of Reptiles.

1. Batrachia.—The development of the respiratory organs in the fœtus of these animals is peculiarly interesting on account of the transition which they undergo from an aquatic to an aërial condition; and the observation of the changes of structure which take place during their transformation, appears to have illustrated, more clearly perhaps than that of any other class of animals, the relations of the respiratory and vascular organs to one another.

Aquatic Salamander.—Shortly after the fœtus or larva of the Aquatic Salamander leaves the egg, its blood is exposed to the influence of the surrounding water on the surface of the rudimentary intestine, or part corresponding with the sac of the yolk in other animals. The vena cava returning from the tail, on arriving at the posterior part of the intestine, gives off a large branch (Fig. 8, *y′*), which is joined by numerous small vessels spread over the lower surface of the abdomen. The small vessels are again united into one venous trunk (*y*), situated near the auricle of the heart, on the left side of the body, where they pour into the heart (*a*) a large quantity of blood which passes over the abdomen, along with that from other parts of the body.

The liver (*c*) is formed in the batrachia, as in cartilaginous fishes and the higher orders of animals, by the subdivision of the venous trunk conveying the blood from the yolk to the heart.

As the development of the fœtus proceeds, its finny tail, as well as the greater part of the integuments of the body, are covered by minute ramifications of vessels, which must contribute materially to aërate more perfectly the blood. As these ramifications become more numerous, the quantity of blood sent over the abdomen becomes less, the liver (Fig. 8. *c*) increases in size, the proper mesenteric vessels are formed, and the trunk of the proper vena cava augments, and carries proportionally a greater quantity of blood directly from the tail to the heart. At the same time, the formation of the external gills, or more special respiratory organ of the fœtus of these animals, commences.

The rudiments of the external gills, very similar in their commencement to the branchiæ of the fœtal fish, are to be found at a very early period. Some days before the fœtus of the Salamander quits the egg, they are indicated by four transverse opaque bands on the fore part of the body, or pharyngeal portion of the intestine. These transverse bands by their farther development form branchial hoops on each side of the neck. The integuments then begin to bud out at the upper and lateral parts of these hoops, so as to form three small projections or folds of the skin, placed severally opposite the interstices between the hoops. According to Rusconi *, before these parts, which are the commencing external gills, receive any vessels, the distribution of arteries in the neck is very simple, and analogous to that noticed by Rathke in the fœtus of the osseous fish. The arterial vessel prolonged from the bulb of the aorta advancing forwards below the neck, is divided into four pairs of smaller vessels, four of which passing round each side of the pharynx, unite with those from the other side below the vertebral column, to form the descending aorta; each pair of vessels, as it is given off by the aorta, passes along one of the branchial hoops. Rusconi has ascertained, and I have repeated his observations with the same result, that these vessels are at first quite simple in their course round the pharynx, and do not give off any branches.

At the time when the embryo comes out of the egg, the little processes which constitute the commencing external gills, are considerably elongated, and are each supplied with a loop of vessel from the outermost part of one of the branchial vascular arches (Fig. 8, *m*). As the stalk of the gill sprouts out farther from the side of the neck, it acquires considerable length, and the loop of the branchial vessel, consisting simply of an outgoing and returning branch, is prolonged into it. When the primitive stalks of the gills have acquired greater length, new buds of the parenchyma begin to appear on their lower sides, forming the commencing leaflets of the gill (Figs. 8 & 10, *h*),

* Amours des Salamandres Aquatiques, et Développement du Têtard, &c.; and in his Descrizione Anatomica degli organi della circolatione delle larve, &c.

and opposite to each of these secondary buds a new branch of vessel is formed by the passage of the blood, directly across the primary stalk, from the outgoing to the returning vessel. As the new buds of the gills become longer, these communicating branches between the primary vessels are produced along with them; new communicating branches are thrown out in their course, while, at the same time, new buds are formed on the primary stalk of the gill. There are generally about thirty of these leaflets on the gills of the larva, at the time that they have attained their full development, which, according to Rusconi, is about the 40th or 45th day; the vessels are then still more minutely ramified on the surface of the leaflets, and as they are almost quite transparent, the circulation of the blood through them forms a truly beautiful spectacle. In this animal, therefore, as in the fish, by tracing the development of these vessels, it is easy to perceive that the branchial arteries and veins are only subdivisions in the course of the aorta itself.

At the period when the gills are fully developed, the distribution of the vessels rising from the heart is the following (Fig. 9): The three foremost pairs only of the branchial vascular arches convey blood to the gills (*m*). At the root of each gill the arterial or outgoing vessel communicates directly, by a short branch, with the vein or returning vessel, so that a considerable portion of the blood propelled into the branchial arteries, along with the whole of that in the fourth or posterior pair of arches, which gives no branches to the gill, is carried directly into the descending aorta (*r s*). From the communicating branch at the root of the foremost gill there arises a small artery (*t*), which is distributed on the parts surrounding the hyoid bone. The parts near the temporal bone receive an artery from the root of the second gill (*t*), and the vertebral artery is given off near the place where the whole of the branchial arches unite to form the roots of the descending aorta (*r*). The anterior extremity, like the pectoral fin of the fish, receives its vessels from the mammary artery (*u*), which arises along with the cœliac, mesenteric, &c. from the descending aorta.

While the external branchiæ are developed, the internal arches upon which they are supported become firmer and more cartilaginous. They are attached anteriorly to the hyoid bone, and appear to be processes of this bone, which are developed only during fœtal life. At the same time, three clefts are formed between these arches on each side of the neck, and below the attachment of the external gills, through which the water taken into the pharynx is driven out by a muscular effort, so as to produce a current near the leaflets of the gills. It is only in the latter stages of fœtal development, however, that the aid of these currents through the branchial apertures is required, owing to the existence in the earlier periods of a very singular provision, lately discovered by my friend Dr Sharpey *, by which, in the batrachian reptiles, as well as in all the mollusca which he has examined, a constant renewal of water is produced, in contact with their respiratory surfaces. Dr Sharpey has shown that, in the batrachia during the early stage of fœtal life, the integuments, and especially those parts on which bloodvessels are minutely distributed, possess an inherent power of producing currents in the water near them, without any perceptible muscular action, of impelling, as it were, the water along the surface, and thus forcing it to be constantly in motion. This power of producing currents is strongest in the covering of the gills themselves, but it also exists to a considerable extent in other parts of the body, especially on the tail and lower part of the abdomen †.

A considerable time before the gills of the salamander arrive at their full size, the rudiments of the lungs, the principal respiratory organs of the adult animal, begin to be formed. The lungs may be perceived, according to Rusconi, about the 23d day of the development of the embryo, and they have attained a considerable size by the time that the gills are perfected. About the 40th day they consist of two long shaped sacs situated behind the stomach, close to the vertebral column. They do not contain any air for some time after their formation. According to Rusconi, the larva of the salamander begins to expel air from its mouth about the 30th day; but it is difficult to conceive how air can at this time be introduced into the lungs

* On the Currents produced by the Respiration, &c. Edinburgh Medical and Surgical Journal, 1830.

† It would be interesting to know if any analogous power exists in the body or gills of the fœtus of those cartilaginous fishes in which external gills are found.

from without, as the deglutition of air, according to the observations of the same author, is not seen to commence before the branchial apertures are closed at the period of transformation. In the progress of development, the lungs become more perfectly formed, they are divided into compartments by the intersection of septa arising from their sides, and the air passages to the pharynx become more distinct.

When the period of transformation approaches, a period varying much according to climate, season, situation, &c. the gills begin to shrink, and their vessels to carry less blood. The vessels ramified on the extremities of the leaflets become obliterated, and the parenchyma of the gill is forthwith absorbed or removed. In about a week after this, so much of the gills has been removed that these organs are now reduced to mere tubercles projecting from the side of the neck. At the same time, the clefts, or branchial apertures into the pharynx, are gradually closed by the adhesion of an opercular fold of the integuments projecting from their anterior side, and the cartilaginous hoops which supported the gills become gradually softer and are removed. The respiration of the salamander is now truly aërial, and this animal rises frequently to the surface of the water to expire and inspire air.

While the transformation in the respiratory organs takes place, the bloodvessels distributed on them also undergo several important changes. The three anterior vascular branchial arches, which previously gave branches to the gills, are now relatively smaller than before (Fig. 11, *m*). The vessels which proceeded to and from the external gills are now wholly obliterated; their communicating branches at the root of the gill-stalks become dilated, and now form part of the continued trunks which wind round the pharynx, and join above it to form the descending aorta (*r s*); so that the branchial arches of the pharynx seem to have resumed the simple form in which they first appeared before the external gills were developed. The arteries going to different parts of the head and neck, and arising from the outer parts of these vascular arches, are now proportionally larger than before. The fourth or posterior pair of arches (*p*) from which the lungs derive their arteries, and which was previously much smaller than the three anterior, now becomes the most considerable. The fourth arch communicates with the third arch, and sends a returning vessel contributing to the formation of the aorta; the principal part of the trunk (*p*), however, descends on each side of the vertebral column to the sac of the lungs, upon the cells or compartments of which it is ramified with great minuteness.

Frog.—During the first part of fœtal development, the respiration of the larva of the common Frog is carried on by nearly the same means as that of the aquatic salamander. The rudimentary intestine, or part corresponding to the yolk sac, seems to be covered by a network of venous vessels, to which the liver holds the same relative position as in the salamander. Branchial appendages, analogous in their structure and relations to those of the salamander, are formed, and the tail, as well as the general integuments of the body, appears to assist the more special respiratory organs in changing the blood. The external branchial appendages exist for a much shorter time in the frog than in the salamander: they never become highly developed, or capable of exposing a large quantity of blood to the influence of the water; but their place is supplied at an early period by internal gills, corresponding in some respects with those of osseous fishes (Figs. 13, and 14, H I).

According to the observations of Baer *, before the external gills become developed, the distribution of vessels in the neck of the tadpole of the frog resembles in its simplicity that in the fœtal fish and salamander. The aorta, rising from the bulb and advancing forwards to the region of the pharynx, is divided into two branches, one of which proceeds to each side of the neck, and gives successively in its course four branchial vascular arches, which, winding round the branchial hoops, reunite with one another on the upper side of the intestine to form the descending aorta.

The external gills generally attain their full size about the 18th day of development (Fig. 13, H.) Soon after this period, they appear to shrink and lessen: their free motion is now impeded by the growth of an opercular fold of the integuments anterior to them (Fig. 13. λ), which, increasing more and more from before backwards, gradually forms a cover which encloses them entire-

* In his Geschichte des Fröschembryo, in Burdach's Physiol. B. ii. S. 222.

ly. On cutting out this opercular fold, the remains of the external gills may be seen for some time after they have been enclosed, but they seem ultimately to be removed by absorption. The internal gills which are in the mean time developed, are by no means, as some have supposed, the enclosed external appendages, but are formed separately on the branchial hoops encompassing the pharynx, like the gills of the adult fish. The outer margin of these branchial hoops is gradually covered with small processes of a soft substance that form the leaflets or comb-like structure of the gills, upon which the minute capillary vessels are afterwards ramified (Fig. 14, A), and these leaflets are not unlike those of the external gills. The branchial hoops are separated from one another by clefts, through which the water introduced into the pharynx passes freely; but after the opercular fold has covered over the external and internal gills, it unites with the integuments on the left side; and only one aperture, situated on the right side, is left, by which the whole of the respired fluid makes its exit from the cavity of the gills *.

As the vessels of the external gills are formed by the subdivision of the simple branchial arches, and no branch is given off from them before they arrive at the gills, the whole of the blood which passes through the heart must necessarily be exposed in these organs to the influence of the water, before it is sent to nourish any other part of the body.

The mode in which the subdivision of the branchial arteries in the larva of the frog takes place has been observed by Rusconi, and is described by him in his anatomical description of the larva of the aquatic salamander.

Each branchial vascular arch, on entering its respective hoop, gives off a lateral branch, considerably larger than the continuation of its own trunk: this lateral branch accompanies the parent vessel along the hoop, and reunites with it before leaving the gill. As these two vessels proceed along the gill, side by side, and at a short distance from one another, the lateral vessel gives off ten or more cross branches, which pass through the buds of the leaflets, and fall again into the parent vessel. The lateral branch, at its first separation very large, thus becomes gradually

* In some species of frog, there is an opening on each side of the neck, as in osseous fishes. See Cuvier's Recherches sur les Reptiles douteux.

smaller as it proceeds onwards; and the parent trunk, very small at the place where it gives off the lateral branch, gradually increases in size by the accession of the cross branches, till it is joined again by the lateral trunk itself. As the leaflets of the gills become larger, they are covered by very numerous capillary vessels, formed by the looping out or subdivision of the cross branches, in a manner somewhat analogous to the extension of vessels in the external gills*. The three anterior pairs of branchial vessels, on coming out of the gills, before uniting with one another and with the posterior pair, to form the descending aorta, give arterial branches to the head, neck, and anterior extremities.

The rudiments of the lungs are to be found adhering to the lower side of the oesophagus, at the time when the external gills are fully formed (Fig. 16, A, *l l'*). As development proceeds, the little dense masses constituting the lungs become hollow (Figs. 13, *l*, and 16, B); they gradually expand, their parietes becoming membranous; they are filled with air, and their cavity is divided into cells by transverse septa rising from their sides (Fig. 14, *l l*). The lungs of the frog, like those of the salamander, receive their vessels from the posterior or fourth branchial arch (Fig. 14, *p*), or that nearest the heart; but in the frog, this artery traverses the gill before arriving at the lung; it becomes gradually larger as the lungs become developed and the period of transformation approaches, till the fœtal life is at an end, when it carries a proportion of blood considerably greater than the three anterior arches.

As the gills shrink and become smaller, the minute vessels of their leaflets first disappear, and then the cross branches from which they arose are obliterated. The apertures or clefts between the branchial hoops are closed up, the leaflets are partly absorbed, and the branchial hoops themselves are gradually softened down and removed. The large lateral branches of the branchial arteries also begin to carry less blood, and are at last

* These two parallel vessels, it is obvious, represent the rudimentary state of the branchial vessels of fishes; the large lateral tributary branch corresponding with the artery, and the main trunk with the vein. It appears not improbable, that the vessels of the gills in fishes are subdivided in a similar manner to that alluded to above; though, at the same time, it must be acknowledged that the double vessel has not as yet been remarked in the fœtal fish.

obliterated when the gills have disappeared, so that the main trunks only of the branchial arteries remain. These (the main trunks) continue to carry blood to the arteries of the head, neck, and anterior extremities (Fig. 15, *t u*). According to Rusconi, the returning branches of the first, third, and fourth arches are obliterated, those of the second only remaining to form the roots of the aorta (*r r'*). The anterior extremities (Fig. 14, *g*) in the mean time increase in size, and break through the skin which covers them. The finny tail shrinks, and is gradually absorbed, and the little frog now leaves the water to return only in search of food or protection.

Funk * and Siebold † have shewn, that as the batrachian reptiles approach to maturity, another organ connected with the respiratory function is developed, which seems calculated for exposing a part of the blood at least to the influence of the oxygenizing medium. A vesicle formed by the extension of the cloacal part of the intestine ‡ becomes expanded so as to occupy a considerable space at the posterior part of the abdomen; the umbilical arteries (Fig. 12, *z*) form a minute vascular network by their subdivision on the surface of this vesicle, and the umbilical vein (*z'*) returning from it conveys the blood which has passed over its surface to the vena portæ and liver, as in the higher animals. This vesicle can only be considered as a rudimentary and imperfect respiratory organ in the batrachian reptiles; but we shall afterwards find that it corresponds with a part which becomes highly developed in the fœtus of lizards, birds, and mammalia, and forms in them a most powerful means of effecting the respiratory changes in the blood.

In speaking of the respiration of the fœtus of batrachian reptiles, it may be interesting to advert shortly to the structure of the adult respiratory organs in some other animals, which appear to be nearly allied to this class, and are now very generally included by naturalists under the same general division. The Proteus anguinus, the Siren lacertina, and the Amphiuma didactylus, and A. tridactylus, the species of those animals

* De Salamandri Terrestri Formatione Vita et Evolutione. Berolini, 1827.

† Quædam de Salamandris et Tritonibus. Berol. 1829.

‡ Seen commencing in the tadpole of the frog in Fig. 14, *v*, and in the adult salamander, Fig. 12.

alluded to best known, appear to be all truly aquatic in their habits, or to live chiefly in water and moist mud; but all of them are provided with organs analogous to the lungs of the adult batrachia, and appear to respire more or less air as well as water.

The principal respiratory organ of the Proteus and Siren is the external gills, into which a large quantity of the blood of these animals is propelled; while the Amphiumas (at least the adult animals) appear to be altogether destitute of gills, and to respire, like the batrachia after they have undergone the transformation, by lungs alone, into which air is from time to time introduced.

Rusconi, in his beautiful memoir on the Proteus anguinus, states, that this animal dies as soon as or sooner than most fishes, when taken out of the water. Mr Neill has observed, that the siren which he possesses lived, upon one occasion, for twelve or fourteen hours out of water, and Cuvier informs us, that the Amphiumas or Abranchi are known frequently to lie in dry places for several days, without sustaining any injury; on the other hand, the whole of these animals, even the abranchous amphiuma, appear capable of remaining below water for a considerable period, without inhaling air, which the existence of lungs in them would lead us to believe is necessary for their respiration.

The external gills of the proteus and siren are fimbriated and branched like those of the salamander; and the principal stalks are suspended, in the same manner, from branchial plates or hoops, which appear to be processes of the hyoid bone. There are also three apertures between these branchial hoops, through which these animals are enabled to expel either air or water, and thus produce currents near the gills.

Though the amphiumas are destitute of any kind of gills, it is a very curious and interesting fact which has been established by Cuvier, that the hyoid bone in these animals bears a considerable resemblance to that of the siren, and other animals in which external gills exist, either permanently or for some period of their life. The hyoid bone consists, in the amphiumas, of a lingual part and two long cornua, which encompass the pharynx. Near the two posterior extremities of these cornua, there are attached three small cartilaginous arches analogous to branchial plates or hoops. Of the spaces between these arches, in which, had there been gills, one would naturally have expected to find branchial apertures, the two anterior are closed up by the membrane lining the pharynx and by integuments, and the posterior only remains open, forming a permanent aperture in the neck in every respect analogous to the branchial apertures of the proteus, siren, and salamanders. Cuvier states, that the examination of the soft parts, as well as of the skeleton, leads him to believe, that at some previous period of its existence, this animal possesses external gills, similar to those of the larva of the aquatic salamander. The observation of the development of the amphiumas in the fœtal state alone, however, will probably enable us to solve this question, as very small specimens (three inches long) have been seen in which no vestige of gills was to be found.

The lungs of the proteus consist of two oval membranous sacs, situated in the posterior part of the abdomen, which are generally only about a twelfth of the length of the body, and are each connected with the pharynx by a long and narrow tube. These sacs are quite smooth in their interior, and are not separated into compartments by membranous septa.

The lungs of the siren and amphiuma, on the other hand, are proportionally much larger than those of the proteus. Those of the siren, according to John Hunter, consist of "two long bags on each side, which begin just behind the heart, and pass back through the whole length of the abdomen, nearly as far as the anus. They are largest in the middle, and honey-combed on the internal surface through their whole length." According to Cuvier, the lungs of the amphiumas are formed by two long cylindrical and very vascular sacs, slightly dilated at the posterior extremity. In neither siren nor amphiumas are there any proper trachea or bronchi.

The heart of these animals seems to hold an intermediate place between that of fishes and batrachia. It consists of a strong fleshy ventricle, a large membranous auricle situated somewhat anterior to and above the ventricle, and a strong muscular bulb, from which the rising aorta springs.

In the proteus and siren, so far as has as yet been ascertained, there are only three branchial arteries formed on each side of the neck by the subdivision of the aorta; each of these vessels gives a branch to one of the gills. The arteries of the head and neck are derived from the branchial veins or vessels which carry back the blood which has passed through the gills, and from communicating vessels passing between the arteries and veins at the roots of the gill stalks. The pulmonary artery is given off at the place where the posterior branchial artery and vein meet and join with the anterior ones to form the roots of the descending aorta.

From the drawing of the Amphiuma Didactylus by Dr Poc-kels, published by Rusconi (which Cuvier has shewn was erroneously taken by these anatomists for the siren), it appears that the distribution of the branchial arches in this animal resembles more that of the larva of the salamander, there being four branchial arteries, the three anterior of which supply the gills, while the posterior, a fourth, alone is ramified on the sac of the lungs.*

(To be concluded in our next.)

Explanation of the Plates.

In all the figures, the following letters indicate the different parts:—

a, The ventricle. *a'*, The auricle of the heart. *b*, The bulb of the aorta. *b'*, The ascending aorta. *c*, The liver. *d*, The stomach. *d'*, The œsophagus. *e*, The mouth. *e'*, The anus. *f*, The eye. *g*, The anterior. *g'*, The posterior extremities. H, The external gills, the stalks. *h*, The leaflets. I, The internal gills or branchial plates. *i*, The leaflets or fringe. λ, The operculum. *k*, The rectum and cloaca. L, The lungs. *l*, The cellular part. *l'*, The trachea. *m*, The branchial vascular arches. *n*, The returning vessels or branchial veins. *o*, The branchial apertures. *p*, The pulmonary arches or arteries. *r*, The left; *r'*, The right root of the descending aorta. *s*, The descending aorta. *t*, The carotid artery. *u*, The brachial, and in Figs. 9 and 11 the mammary. *w*, Communicating vessels of the branchial arches which are obliterated. *v*, The urinary bladder and allantois. *x*, The artery of the yolk. *y'*, The vein carrying blood to the yolk. *y*, The returning vein of the yolk. *z*, The umbilical artery. *z'*, The umbilical vein. δ, Ductus arteriosus.

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* For a farther account of these animals, see Configliachi and Rusconi Del Proteo Anguino di Laurenti Monografia. Pavia, 1819, of which an account is given by D. Ellis, Esq., in Vols. iv. and v. of this Journal.—Cuvier, Recherches sur les Reptiles douteux, in Humboldt's and Bonpland's Recueil d'Observations, &c.—Mémoires du Museum d'Hist. Nat., tome xiv. 1827. Sur le Genre de Batraciens nommé Amphiume.—Philosoph. Trans. by Shreibers and John Hunter.—Wilson's Illustrations of Zoology.

ι, Inferior maxilla. η, The amnios. ϱ, The chorion. χ, The ductus vitello intestinalis.

Fishes.

Fig. 1. (From Rathke) Supposed section of the fœtus of the Blennius Viviparus, at the middle of fœtal life.

2. (From do.) The anterior part of the body of a very young embryo of the same fish magnified seven times, the sac of the yolk and integuments covering it removed.
3. (From do.) The same seen from below; the heart removed; the abdomen opened to shew the intestinal tube.
4. (From do.) Another embryo farther advanced. The operculum covering the first and second branchial plates.
5. (From do.) The same seen from below.
6. (From Monro) The fœtus of the skate with the yolk sac, half the size of the original. A, Anterior part of the body of the natural size, shewing the external gills suspended from the branchial apertures on the lower side of the body.
7. Anterior part of the fœtus of the Squalus Max.; half the natural size, seen from above, shewing the external gills. A, The extremity of one of the gill filaments magnified.

Reptiles.

1. *Batrachia.*

8. Fœtus of the Aquatic Salamander one day after its exit from the egg, seen from below. A, Natural size.
9. (From Rusconi) Head, &c. of the larva of the same animal at the time when the gills are nearly perfected, opened, and seen from above. Magnified.
10. (From the same) Shews the leaflets of the gills forming.
11. (From do.) The vessels in the neck of the adult Salamander.
12. (From Carus) The adult Salamander opened, to shew the urinary bladder or allantois, with the umbilical vein going from it to the liver.
13. The larva of the frog about 24 days old; shews the connexion of the external with the internal gills, and the left lungs beginning to be formed. A, The natural size.
14. The larva of the frog at the time of the commencement of its transformation, twice the natural size. A, Exhibits the double row of leaflets on the internal gill.
15. (From Swammerdam) The principal arteries of the adult frog.
16. The commencing lungs of the frog; A, in the tadpole on the 18th day, seen from below; B, in the tadpole represented in Fig. 13. seen from the side.

2. *Lizards, &c.*

17. (From Emmert and Hochstetter) Ovum of the Lacerta agilis, shewing the fœtus in its amnios, the yolk and allantois with their vessels.
18. (From Dutrochet) Supposed section of the ovum of the Serpent, shewing the allantois expanding.
19. (From Bojanus) The heart and arterial vessels of the Testudo Europæa from behind.

Birds.

20. Anterior part of the fœtus of the Duck four days and a-half old, seen on the right side. Magnified about seven diameters.

21. (From Baer) Section of the chick in ovo on the fourth day.
22. (From Rathke) Embryo of the chick on the fifth day. Magnified one diameter.
23. (From do.) Longitudinal and vertical section of the head and neck of the chick on the fifth day, shewing the interior of the pharynx and the remains of the branchial apertures.
24. (From do.) Heart and anterior part of the neck of the same embryo, shewing the infer. maxilla and operculum.
25. Posterior view of the heart and interior of pharynx, at a corresponding period, shewing the branchial arches given off by the bulb of the aorta. A, Section of the extremity of the bulb.
26. (From Rathke) A, The lower, and B, The lateral view of the lungs and trachea of the chick on the fifth day, with the œsophagus.
27. (From do.) The same on the sixth day.
28. (From do.) The same on the seventh day.

(From do.) The lungs, &c. on the eleventh day, shewing the trachea, aorta, pulmonary arteries, communicating vessels, and the union of the cellular, with the bronchial parts of the lungs.

30. (From Burdach, but reversed.) Diagram shewing the branchial divisions of the aorta of the chick on the lower side of the pharynx, and the mode of their transformation into the aortic and pulmonary vessels.
31. The position of the ductus arteriosi relatively to the œsophagus in the chick about the 12th day.

Mammalia.

32. (From Bojanus) Sketch shewing the relative position, size, &c. of the allantois and yolk-sac, &c. in the fœtus of the sheep about three weeks old. A, The fœtus and umbilical vesicle magnified. B, A small part of the fœtal placenta or cotyledon of the calf, shewing the processes of the chorion on which the umbilical vessels are ramified.
33. (From Bojanus) The same in the dog of 24 days.
34. The same in the rabbit of about fourteen days, with the placenta. A, The entire ovum. B, The chorion and umbilical vesicle opened, so as to shew the allantois and placenta.
35. The head and neck of the embryo of the dog of three weeks, represented by Baer, and copied from Fig. 8. of former Essay.
36. The human embryo of about six weeks, in which I found two branchial apertures at least on each side of the neck, the heart exposed. A, The natural size.
37. (From Rathke) Anterior view of the neck of the fœtus of the pig, represented in Fig. 9. of former Essay, shewing the branchial apertures and operculum.
38. Heart and branchial arches in the rabbit, Fig. 34.
39. Diagram of the branchial arches of mammalia, and their transformations, corresponding with that of birds by Burdach. A, Ductus arteriosus of mammalia when just formed.
40. Posterior view of the heart and commencing lungs and trachea of the rabbit, Fig. 34. Magnified three diameters.
41. (From Rathke) The tongue, trachea, and lungs of the fœtal horse seen from above, twice the natural size. A, The same seen from below. B, Section.
42. (From do.) Lungs of the pig farther advanced, twice the natural size, seen from below. A, The same, seen from above. B, Section.
43. The heart, lungs, pulmonary and aortic vessels, and ductus arteriosus of the human embryo of ten weeks, twice the natural size.

On the Characters and Affinities of certain Genera chiefly belonging to the Flora Peruviana. By Mr David Don, Librarian to the Linnean Society, Member of the Imperial Academy Naturæ Curiosorum, of the Royal Botanical Society of Ratisbon, and of the Wernerian Society of Edinburgh, &c.

The object of the present memoir is an attempt to illustrate some of the more obscure genera published in the *Flora Peruviana et Chilensis*, a work containing a rich fund of interesting materials; but which, from its plan, it is much to be regretted, is, in many instances, unavailable for the purposes of science, the descriptions being often too meagre, and the details of the plates rarely sufficient for determining satisfactorily the classification of the new genera therein proposed. The examination, however, of authentic specimens in the Herbarium of Ruiz and Pavon, has rendered a task comparatively easy, which otherwise would have been very difficult, if not wholly fruitless. To illustrate the characters of groups already established, and to determine their several stations in the system of Nature, is of much more importance to the advancement of science, than the discovery of new species, or the forming of new combinations.

I cannot hope to have been equally fortunate in all cases; but if I have succeeded, even in an approximation to ascertaining the characters and affinities of these genera, my utmost expectations will be fulfilled.

CLEOMELLA, *Decand.*

Syst. Linn. HEXANDRIA MONOGYNIA.

Ord. Nat. CAPPARIDEÆ, *Juss.*

Calyx monophyllus! 4-fidus: *laciniis* ovato-oblongis, mucronatis (ut in *foliis!*) integerrimis. *Petala* hypogyna, laciniis calycinis alterna, elliptico-oblonga, obtusa, subcarnosa, venosissima, integerrima: *ungue* brevissimo. *Stamina* 6, æqualia, glandulæ elevatæ magnæ truncatæ inserta: *filamenta* subcapillaria, glabra: *antheræ* longæ, lineares, subtetragonæ, obtusæ, biloculares, basi insertæ, ad floris expansionem spiraliter revolutæ! *loculis* parallelis, bivalvibus, suturâ longitudinali exteriùs dehiscentibus.

Ovarium pedicellatum, ovatum, compressum, uniloculare: *ovulis* pluribus. *Stylus* brevissimus, glaber. *Stigma* simplex, truncatum. *Capsula* pedicellata, compressa, triangularis, truncata, unilocularis, bivalvis, decasperma: *valvis* navicularibus, in angulum prominentem productis (compressione cauli contrario), quasi transversis: *suturæ* intùs magis prominulæ, funiculis umbilicalibus, complanatis persistentibus instructæ. *Semina* simplici gyro cochleata, extremitatibus connatis! umbilico in sinu; *testa exterior* crustacea, lævis; *interior* cartilagineo-membranacea: *albumen* nullum. *Embryo* flexurâ arctâ teres, luteus: *cotyledonibus* incumbentibus, semicylindricis: *radicula* his parùm longiore, basi acutâ.

Planta (Mexicana) *suffruticosa, procumbens, glaber, glauco-virens.* Caules *plurimi, teretes, ramosissimi.* Folia *alterna, petiolata, ternata:* foliolis *breviter stipitatis, cuneiformibus, retusis cum mucronulo reflexo, integerrimis, 3–4-linearibus.* Petioli *semicylindrici, 3–6 lineas longi.* Stipulæ *2, setaceæ, brevissimæ.* Flores *axillares, solitarii, pedunculati, albi.* Pedunculi *subcapillares, semipollicares.*

1. C. *mexicana.*
Cleomella mexicana, *Decand. Prod.* 1. p. 237.
Cochlearia trifoliata, *Sesse et Mocinno MSS.*
Hab. in Mexico. *Sesse et Mocinno.* ♃ (V. s. sp. in Herb. Lamb.)

A genus first proposed by my candid and learned friend M. De Candolle, in the second volume of his *Prodromus Systematis Naturalis Regni Vegetabilis,* where the essential characters are given; but I have thought that a detailed description, derived from the examination of several complete specimens, might be desirable, especially as it is probable M. De Candolle had not an opportunity of seeing specimens of it, but had derived his knowledge of the genus from the unpublished drawings of the *Flora Mexicana.* This genus is interesting, as exhibiting, both in its habit and structure, an evident affinity to the *Tropæoleæ,* which I have elsewhere proposed to place near to *Cruciferæ* and *Capparideæ.* The *Balsamineæ,* which I also formerly proposed to add to this class, I am now fully persuaded must be arranged near to *Violeæ*—to which, even in the nervation and dentation of their leaves, they exhibit a closer affinity. The placentæ in *Cleomella* are very prominent, and extend sometimes considerably within the capsule, constituting a sort of partition; and as the rudiment of a connecting membrane, analogous to the dissepiment in *Cruciferæ,* is occasionally observable in the young ovarium, it is probable that that organ is wholly absorbed in the very early stage of the ovarium, in *Capparideæ.*

PARNASSIA, *L.*

Syst. Linn. PENTANDRIA TETRAGYNIA.
Ord. Nat. HYPERICINÆ, *Nobis.*

Calyx 5-phyllus, persistens: *foliolis* obtusissimis, æstivatione imbricatis. *Petala* 5, calycinis foliolis alterna, persistentia. *Stamina* hypogyna; *fertilia* 5, petalis alterna, filamentis subulatis, compressis, glabris; *sterilia* 15 v. plurima, filamentis basi in 5 phalanges connatis! apice distinctis, antherarum rudimentis minimis! *Antheræ* incumbentes, biloculares: *loculis* parallelis, bivalvibus, suturâ longitudinali dehiscentibus, connectivo latiusculo distinctis: *valvulis* coriaceis: *receptaculo* dilatato: *pollen* farinaceum. *Ovarium* uniloculare: *ovulis* erectis, numerosissimis. *Stigmata* 4, crassiuscula, obtusa, densè papillosa, recurvula. *Capsula* (è folliculis 4 marginibus connatis constituta) unilocularis, 4-valvis, rimâ in medio cujusque loculi quadrifariàm dehiscens: *valvulorum marginibus* connatis, intùs prominentibus et placentiferis. *Semina* numerosa, parva; *testa exteriori* membranaceâ, nucleo ampliori, punctatâ, in alam extensâ; *interiori* crassiori, subcoriaceâ: *albumen* nullum. *Embryo* erectus, teres: *radiculâ* longâ, cylindraceâ, inferâ, centrifugâ.

Herbæ (in paludosis regionum temperatarum provenientes) *perennes, glabræ, copiosè lentiginosæ!* Caules *erecti, sulcati, uniflori, folio unico amplexicauli muniti.* Folia *petiolata, cordata, radicalia, integerrima, nervosa, pellucido-punctata!* Flores *albi, magni.* Petala *cum calyce multinervia, pellucido-punctata et densè lentiginosa.*

Obs. Tota ferè planta sub lente pellucido-punctata et lentiginosa! Structura fructificationis partium omninò cum Hypericinis convenit Parnassia, atque nervatione foliorum, calycis petalorumque.

* *Staminibus sterilibus in singulâ phalange plurimis.*

1. P. *palustris*, petalis subrotundis unguiculatis; nervis extimis ramulosis, foliis cordatis.

Parnassia palustris, *L.*

Hab. in Europææ borealis paludosis, et in Sibiriâ. ♃ (V. v. sp.)

Petalorum unguis brevissimus, contractus. *Nervi intermedii* subsimplices. *Stamina sterilia* setacea, ovario duplò longiora.

* * *Staminibus sterilibus in singulâ phalange definitis* (3 *v.* 5).

2. P. *ovata*, petalis ellipticis ungue dilatatis; nervis extimis ramulosis, staminibus sterilibus ovario longioribus, foliis ovalibus.

Parnassia ovata, *Ledeb. in Act. Petrop.* 1815. p. 514?
P. ovata *β*, *Decand. Prod.* 1. p. 320.

Hab. in Sibiriâ orientali (*Ledebour*), in Canadâ. *Pursh.* ♃ (V. s. sp.)

Sequenti proxima, sed duplò triplòve minor, nervis intermediis petalorum subsimplices, staminibus sterilibus ovario longioribus.

3. P. *caroliniana*, petalis oblongis: nervis omnibus ramulosis, staminibus sterilibus ovario brevioribus, foliis cordatis.

Parnassia caroliniana, *Mich. Fl. Amer. Bor.* 1. p. 184. *Pursh Fl. Amer. Sept.* 1. p. 208. *Bot. Mag.* t. 1459.

Hab. in Americâ boreali. ♃ (V. v. c. et s. sp.)

Petala oblonga, ungue dilatato.

4. P. *asarifolia*, petalis oblongis; nervis extimis pulchrè divaricato-ramulosis, staminibus sterilibus ovario ter longioribus, foliis reniformibus.

Parnassia asarifolia, *Vent. Malm.* t. 39. *Pursh, Fl. Amer. Sept.* 1. p. 208.

Hab. in Americâ boreali. ♃ (V. v. c. et s. sp.)

Omnium maxima. *Folia radicalia* reniformia, bipollicem lata; *caulinum* subrotundo-cordatum. *Petala* uncialia; *nervis extimis* pulcherrimè ramulosis; *cæteris* simplicibus, basi connatis.

Obs. P. grandifolia, Decand. huic videtur maximè affinis, an satis differt?

5. P. *fimbriata*, petalis obovato-oblongis tripli-nerviis basi fimbriatis, staminibus sterilibus 25 ovario duplò brevioribus, foliis reniformibus.

Parnassia fimbriata, *Kon. in Ann. Bot.* 1. p. 391. *Smith, in Rees' Cyclop. in loco. Decand. Prod.* 1. p. 320. *Hook. Bot. Misc.* 1. t. 23.

Hab. in orâ occidentali Americæ borealis. *Menzies.* ♃ (V. s. sp. in Herb. Smith.)

Petala obovata, unguiculata, trinervia: *nervis* basi connatis; *lateralibus* trichotomis.

Botanists have long been divided in opinion respecting the affinities of this highly interesting and curious genus of plants. Jussieu included it along with *Drosera* among his *Capparides*, and his opinion has been adopted by De Candolle, who has placed it in his family *Droseraceæ;* and by the late Sir James Edward Smith and Mr Lindley it has been referred to *Saxifrageæ*. I am satisfied, however, that neither of these views is correct; and after a most careful examination, it appears to me that its true place in the natural system is among the *Hypericinæ*, with which it agrees in every essential point of structure, even to the nervation of its leaves and petals. The capsule is formed on precisely the same plan; the ovula are attached to the marginal placenta of the valves, whose inflected edges in both are united; but they are considerably more extended interiorly in the true *Hypericinæ*, and constitute the dissepiments of the capsule. The seeds of *Parnassia*, like those of *Hypericinæ*, are destitute of albumen, and otherwise their structure is precisely similar. The embryo is erect and cylindrical, having a long radicle pointing towards the hilum, and very short cotyledons. The anthers are bilocular, and incumbent with parallel cells; and the stigmata are like those of *Hypericinæ*, simple and papillose. In *Sarothra*, the stamina seldom exceed five; and in some others of the normal group of *Hypericinæ*, their number is also definite: but I do not mention these examples of reduction of stamina, to show that there necessarily is any analogy between them and *Parnassia*, because I consider their number as indefinite in the latter genus; and I am fully convinced that no one, who examines the subject with that attention it deserves, will be disposed to question the accuracy of the views here adopted; for, except the difference in habit, there is no other character by which *Parnassia* can be separated from the *Hypericinæ*. In conclusion, I may observe, that a comparison of the structure and nervation of the leaves, calyx, petals, and even the anthers and capsule, in this genus, affords a beautiful illustration of the origin and nature of these parts.

PINEDA, *Ruiz et Pavon.*

HOMALII SP., *Pers.*

Syst. Linn. POLYANDRIA MONOGYNIA.

Ord. Nat. HOMALINÆ, *Brown. Decand.*

Perianthium patens, 8- v. 10-partitum, persistens, calycinum: *segmentis* duplici ordine digestis, ovato-oblongis, acutiusculis, coriaceis, æstivatione imbricatis; *exterioribus* parùm majoribus. *Petala* o. *Faux* annulo parùm elevato densè piloso aucta: *stamina* multiplici ordine copiosissima, fauci perianthii inserta: *filamenta* capillaria, glabra, arcuata: *antheræ* subrotundæ, extrorsæ, biloculares: *loculis* gibbosis, longitudinaliter dehiscentibus. *Ovarium* uniloculare: *ovulis* indefinitis, funiculis umbilicalibus stipitatis, adscendentibus. *Styli* plerumque 4, rariùs 3 v. 5, in unum 3–5-angulum connati, singuli e vasorum fasciculis duobus constituentes, medio depressi, adeò subinde sulcato-carinati. *Stigmata* totidem, simplicia, obtusa, pruinosa. *Capsula* (Bacca ex R. et P.) libera, crustacea, unilocularis, evalvis! apice intra stylos fissurâ dehiscens. *Placentæ* plerumque 4, rariùs 3 v. 5, angustæ, parietales, stigmatibus numero æquales, iisdemque alternantes, è confluentiâ vasorum primariorum ramulorum lateralium ortum ducentes, perianthii segmentis collateralibus interioribus oppositæ. *Semina* ad maturitatem pauca, pedicellata, adscendentia, subrotundo-obovata, apice depressa, fusca, latere interiore raphe dilatatâ nudâ instructa, arillata! *arillo* crassiusculo, celluloso, vix succulento: *testa exterior* subcrustacea; *interior* exteriori adhærens, tenuissimè membranacea, pulcherrimè cellularis, pallidè fuscescens, apice areolâ (chalazâ) subrotundâ fuscâ notata, basi foraminulo usque ad embryonem perforata! *albumen* copiosum, carnosum, album. *Embryo* erectus: *cotyledones* reniformes, planæ, subfoliaceæ: *radicula* teres, crassa, obtusissima, cotyledonibus brevior, umbilico prona. *Plumula* inconspicua.

Frutex (Peruvianus) *erectus, ramossimus, biorgyalis.* Rami *teretes.* Folia *undique sparsa, petiolata, elliptico-oblonga, mucronulata, v. rariùs obovata, retusa ac sæpè manifestè emarginata, plana, ad apicem subserrata, infernè integerrima, utrinque ramulisque pube simplici brevissimâ incano-tomentosa, subtùs magis canescentia, costâ prominulâ, venis subimmersis arcuatis, longitudine valdè variabilia, sæpe è semunciâ ad bipollicem.* Petioli *tomentosi suprâ leviter canaliculati, subtùs convexi, 2-lineares, basi ramulis articulati.* Stipulæ 2, *parvæ, subulatæ, tomentosæ, lineam longæ, deciduæ.* Flores *plures (3 v. 5) terminales, corymbosi.* Pedunculi *filiformes, uniflori, tomentosi, semipollicares, apice vix incrassati, basi, ut petioli, similiter articulati.* Perianthium *undique tomentosum.* Stamina *plurima, flava.*

Obs. Perianthium quandoque 11-partitum, additâ laciniâ minore semper ad seriem interiorem, sed non ad exteriorem. Glandulæ ad laciniarum bases mihi nondùm detectæ.

1. P. *incana.*

Pineda incana, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 133. *Gen.* p. 76. t. 14. *Fl. Peruv. et Chil.* tom. 5. ined. t. 428. *Decand. Prod.* 2. p. 54.

Homalium incanum, *Pers. Syn.* 2. p. 82.

Hab. in Peruviæ præruptis versus Huariaca et D. Raphaëlis Tarmæ vicos. *Ruiz et Pavon.* ♄. Floret Februario et Martio. *Vulgò* Lloqui. (V. s. sp. in Herb. Lamb.)

Obs. Lignum ad baculos conficiendos optimum. *Ruiz et Pavon.* l. c.

AZARA, *Ruiz et Pavon.*

Syst. Linn. POLYANDRIA MONOGYNIA.
Ord. Nat. HOMALINÆ, *Brown. Decand.*

Perianthium persistens, calycinum, 4–7-partitum. *Petala* o. *Stamina* basi calycis inserta, definitè numerosa v. indefinitè numerosissima, incurvata: *filamenta* capillaria, glabra, persistentia: *antheræ* subrotundæ, extrorsæ, biloculares, duplici rimâ longitudinali dehiscentes. *Ovarium* globosum, uniloculare: *ovulis* indefinitis, adscendentibus. *Stylus* (è 3 conflatus) subtrigonus, trisulcus. *Stigma* tubercula 3, minutè papillosa. *Bacca* globosa, unilocularis, oligosperma, apice fissurâ in styli basi dehiscens. *Placentæ* 3, parietales, stigmatibus alternantes, è ramulorum lateralium vasorum primariorum confluentiâ constitutæ. *Semina* ad maturitatem paucissima, sæpè solitaria, adscendentia, angulata, fusca, arillo spongioso vestita (an subbaccata?); *testa exterior* crustacea; *interior* membranacea: *raphis* dilatata: *chalaza* dilatata, areolata: *umbilicus* basilaris, perforatus: *albumen* copiosum, carnosum, basi umbilicali perforatum! *Embryo* erectus: *cotyledones* reniformes, subfoliaceæ: *radicula* teres, cotyledonibus brevior, obtusissima, umbilico obversa.

Arbores (Chilenses) *frondosæ.* Folia *alterna, simplicia, petiolata, stipulata, sapore amarissimo.* Flores *corymbosi v. spicati, albi, fragrantes.*

Sect. I. *Perianthium* 5–7-partitum, patens: *laciniis* æstivatione subimbrecatis, basi inappendiculatis. *Stamina* indefinitè et inordinatè numerosissima. *Filamenta plurima* sterilia.

Folia *dentata.* Stipulæ *foliaceæ, inæquales; alterâ maximâ, subpersistente.*

1. A. *dentata*, foliis ovatis serratis scabris subtùs tomentosis, corymbis sessilibus paucifloris.

Azara dentata, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 138. *Fl. Peruv. et Chil.* tom. 5. ined. t. 465. f. *a.*

Hab. in nemoribus Conceptionis Chili. *Ruiz et Pavon.* ♄. *Vulgò* Corcolen. Fl. à Junio ad Septembrem. (V. s. sp. in Herb. Lamb.)

Frutex biorgyalis, cortice spadiceo. *Ramuli* teretes, tomentosi. *Folia* copiosa, alterna, undique versa, petiolata, ovata v. elliptica, mucronulata, serrata, subcoriacea, margine parùm reflectentia, costâ venisque prominulis, suprà nitidula, setulis minutissimis callosis scabra, subtùs pube simplici copiosissimâ canescentia, pollicaria v. sesquipollicaria. *Petioli* semicylindrici, tomentosi, ramulo articulati, sesquilineam longi. *Stipulæ* 2, stipitatæ, foliaceæ, subrotundo-ovatæ, consistentiâ aliisque foliis simillimæ; *alterâ* minimâ, sæpiùsque caducâ. *Corymbi* axillares, axi (ramulo) brevissimo folioso, 3- v. 5-flori. *Pedunculi* teretes, vix semunciales, ut et *perianthium*, densè tomentosi. *Perianthium* persistens, calycinum, simplici ordine 5- v. 7-partitum: *laciniis* lanceolatis, acuminatis. *Sta-*

mina inordinatè numerosa, incurvata, disco villosissimo inserta; plurima sterilia: *filamenta* capillaria, glabra, persistentia; *antheræ* subrotundæ, extrorsæ, biloculares, duplici rimâ longitudinaliter dehiscentes. *Ovarium* globosum, uniloculare. *Stylus* subtrigonus, trisulcus. *Stigma* tubercula 3, minutè papillosa. *Bacca* globosa, unilocularis, oligosperma, nunc sæpè monosperma, apice in styli basi fissurâ dehiscens. *Placentæ* 3, parietales. *Semina* ad maturitatem paucissima, angulata. Cætera omninò ut in genere.

Obs. Perianthium quandocunque ultrà 5-partitum laciniæ additæ sunt semper minores. An villi disci stamina sterilia?

2. A. *serrata*, foliis oblongis serratis lævibus, corymbis pedunculatis multifloris.

Azara serrata, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 137. *Gen.* t. 36. *Fl. Peruv. et Chil.* tom. 5. ined. t. 465. f. *b.*

Hab. in Chili nemoribus provinciarum Conceptionis, Puchacay, Itatæ, Cauquenes et Rere. *Ruiz et Pavon.* ♄. Floret Septembri et Octobri. *Vulgò* Corcolen. (V. s. sp. in Herb. Lamb.)

Frutex biorgyalis, comâ ferè globosâ. *Ramuli* teretes, hirsutissimi. *Folia* sparsa, petiolata, oblonga, v. lanceolata, mucronulata, grossè serrata, membranacea, utrinque pilis sparsis ornata, lævia tamen et pellucido-punctata! basi sæpiùs acutiuscula, pollicaria v. bipollicaria, aut nunc ultrà. *Petioli* vix semipollicares, densè hirsuti. *Stipulæ* foliaceæ, inæqualissimæ, subrotundæ, serratæ, petiolatæ, foliis propriis simillimæ; *altero* minimo, plerumque caduco, aut omninò abortivo. *Flores* triplò minores, corymbosi. *Corymbi* axillares, pedunculati, multi (10–15)-flori. *Pedunculus* pollicaris, teres, pubescens, squamulis (foliorum rudimentis) sparsis membranaceis hirsutis caducis munitus. *Pedicelli* capillares, pubescentes, 4 lineas longi. *Perianthium* persistens, pubescens, simplici ordine 5–7-partitum: *segmentis* lanceolatis, obtusis, membranaceis. *Stamina* plurima, disco villosissimo inserta: *filamenta* capillaria, incurvata, glabra: *antheræ* subrotundæ, biloculares: *loculis* gibbosis, extrorsùm rimâ longitudinaliter dehiscentibus. *Stylus* trigonus, trisulcus. *Stigma* tubercula 3, minutè papillosa. *Ovarium* uniloculare: *ovulis* indefinitis. *Bacca* unilocularis, in styli basi dehiscens. *Placentæ* 3, parietales. *Semina* ad maturitatem pauca, adscendentia, angulata. Cætera omninò ut in genere.

Obs. Vidi ramulos floribus majoribus, staminibus paucioribus instructos; alios floribus minoribus, staminibus numerosis, filamentis sterilibus plurimis atque ovario minimo. Anne flores hi sunt masculi; illi hermaphroditi, et ideoque frutex polygamus?

Sect. II. ALMEJA. *Perianthium* limbo connivens, 4-fidum: *lobis* basi interiore squamulâ auctis! æstivatione valvatis. *Stamina* definitè numerosa, in fasciculis laciniis perianthii alternis; omnia fertilia.

Folia *plerumque integerrima.* Stipulæ *subæquales, persistentes.* Flores *spicati.*

3. A. *integrifolia*, foliis obovatis oblongisve integerrimis glabris, stipulis cordatis subæqualibus, floribus spicatis.

Azara integrifolia, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 138. *Fl. Peruv. et Chil.* tom. 5. ined. t. 466. f. *a.*

Hab. in Chili nemoribus ad Conceptionem. *Ruiz et Pavon.* ♄. Floret Julio et Augusto. *Vulgò* Corcolen (V. s. sp. in Herb. Lamb.)

Arbor 3-orgyalis, erectus, ramosissimus, frondosus. *Ramuli* teretes, densè pubescentes. *Folia* sparsa, petiolata, obovata v. oblongo-elliptica, mucronulata, integerrima, v. nunc rariùs dentata, coriacea, utrinque plana, glaberrima, margine parùm reflexa, basi attenuata, pollicaria v. bipollicaria. *Petioli* suprà canaliculati, subtùs convexi, puberuli, vix 4 lineas longi. *Stipulæ* 2, subæquales, persistentes, stipitatæ, subrotundo-cordatæ, integerrimæ, v. nunc rarò dentatæ, retusæ cum mucronulo, basi sæpè obliquæ, semunciales. *Flores* spicati, fragrantissimi, minores, excavationibus racheos inserti. *Spicæ* axillares, multifloræ, pedunculatæ, pendulæ, plerumque solitariæ, longitudine sæpè unciales. *Pedunculus* cylindricus, tomentosus. *Bracteolæ* ovato-lanceolatæ, acutæ, intùs pilosæ, basi concavæ, caducæ, floribus æstivantibus longiores. *Perianthium* subglobosum, substantiâ crassum, coriaceum, 4-fidum: *lobis* ovatis, acutiusculis, intùs densè barbatis, æstivatione valvatis, basi interiore squamulâ brevissimâ truncatâ crassiusculâ subcarnosâ auctis! *Stamina* definitè numerosa (12 v. 16), in 4 phalanges cum lobis perianthii et squamulis (serie perianthii interiore) alternantia, approximata, disco piloso imposita: *filamenta* capillaria, glabra: *antheræ* parvæ, reniformes, biloculares: *loculis* gibbosis, exteriùs longitudinaliter dehiscentibus. *Ovarium* globosum, uniloculare: *ovulis* plurimis, adscendentibus, placentis 3 parietalibus insertis. *Stylus* subtrigonus, trisulcus. *Stigmata* tubercula 3, minutè papillosa. Cætera mihi ignota.

* * * *Species Dubia.*

4. A? *celastrina*, foliis subrotundo-ovalibus subserratis glabris, stipulis minimis æqualibus, floribus axillaribus fasciculato-paniculatis.

Hab. in Chili. *Caldcleugh.* ♄. (V. s. sp. in Herb. Lamb.)

Frutex ramosissimus, *Celastri* facie. Rami teretes, flexuosi, cortice scabro transversè rimoso. *Ramuli* tenuissimè velutini. *Folia* alterna, petiolata, subrotundo-ovalia, subserrata, nunc rariùs ferè integerrima, coriacea, utrinque glabra, suprà nitida, subtùs opaca, venisque prominulis reticulata, atque in earum axillis pilosa, margine obtuso, calloso, parùm revoluto; pollicaria v. sesquipollicaria, unciam v. minùs lata. *Petioli* simplicissimi, semicylindrici, 2–3 lineas longi, tenuissimè velutini. *Stipulæ* 2, minutæ, oblongæ, squamæformes, canaliculatæ, subitè caducæ. *Flores* axillares, paniculati, parvi. *Paniculæ* solitariæ, parvæ, axi abbreviatissimo fasciculatæ, tomentosæ. *Pedicelli* brevissimi. *Bracteolæ* squamæformes, minutæ, caducæ. *Perianthium* densè tomentosum, 4–5-partitum: *laciniis* ovatis, margine obtusis, muticis, patentibus. *Petala* nulla. *Stamina* definitè numerosa (12 v. 15); omnia fertilia: *filamenta* capillaria, glabra, perianthio longiora: *antheræ* subrotundæ, basi insertæ, extrorsæ: *loculis* connatis, longitudinaliter dehiscentibus. *Ovarium* uniloculare: *ovulis* plurimis, placentis 3 parietalibus insertis. *Stylus* trigonus. *Stigmata* puncta 3, minutè papillosa. Cætera mihi ignota.

Obs. Anne flores dioici?

The *Homalinæ* may be regarded as occupying, in the series of natural affinities, an intermediate station between *Rosaceæ* and *Prockiaceæ*, to each of which, respectively, they approach, both in habit and characters. The stamens, like those of *Rosaceæ*, are inserted in the calyx, whose segments are also frequently disposed in a double series; and to *Prockiaceæ* they approach in their unilocular ovarium, and in the structure and insertion of their seeds. The close relationship of *Prockiaceæ* and *Tiliaceæ*, I consider as clearly established; the chief distinction of the latter family, consisting in the valvular æstivation of their calyx, and in their multilocular ovarium. I am aware that *Azara* and *Pineda* have hitherto been considered as belonging to separate families; but, I trust, the above description will establish their intimate affinity, and prove that they belong to one and the same family. Persoon had referred *Pineda* to *Homalium*, and M. Decandolle has adopted this indication of affinity, but has very properly retained it as a separate genus. In the arrangement of *Azara*, however, he has been less fortunate, as he has followed the suggestion of M. Kunth, who had proposed to place it among the *Bixinæ*, or *Prockiaceæ*, a name which I greatly prefer, as being derived from a genus that affords a much better idea of that order than *Bixa*, which may be considered as an aberrant member of it. The valvular æstivation of calyx is not general throughout *Tiliaceæ*, for in some plants, clearly referable to that family, the margin of the lobes is folded inwards, and in *Sloanea dentata* and *emarginata* the lobes are slightly imbricated, and certainly decidedly so in the genus *Trichocarpus*. The large rough prickly capsule of *Bixa*, and the entire habit of the genus, correspond so exactly with *Sloanea*, that they may very properly be considered as forming the connecting links of the two families; and as a further proof of their close relationship, I may adduce the thickening of the petioles near the insertion of the leaf in both genera,—a circumstance which is not found in any of the other genera that have been referred to the *Prockiaceæ*, although frequent in *Tiliaceæ*. Some analogies in structure might be pointed out between *Prockiaceæ* and *Cistinæ*, on the one hand, and between *Homalinæ* and *Passifloreæ*, on the other, but in neither case amounting to an indication of affinity. *Neillia*, formerly referred by me to the *Spiræaceæ*, may be regarded as forming the rudiment of a distinct group, more intimately allied to *Homalinæ*, being chiefly distinguished from the former by the presence of petals, and by the very reduced number of its pistilla, which are uniformly solitary. The *Abatia* of Ruiz and Pavon, which M. Kunth has doubtfully referred to his *Bixinæ*, appears to me clearly to belong to *Salicariæ*, with which family it corresponds, in the seeds being destitute of albumen, and in its opposite leaves clothed with tufted pubescence, as is often the case in *Cuphea*, and some other genera of the same natural family. The following description of this curious genus will show these affinities in a clearer point of view.

ABATIA, *Ruiz et Pavon.*

Syst. Linn. POLYANDRIA MONOGYNIA.
Ord. Nat. SALICARIÆ, *Nobis.*

Calyx monophyllus: *tubus* brevissimus, subturbinatus: *faux* pilis muticis filamentosis numerosissimis (vix tamen stamina sterilia) munita: *limbus* 4-partitus: *laciniis* lanceolatis, æstivatione valvatis. *Petala* nulla. *Stamina* definitè numerosa (20) simplici ordine! prope tubi calycis basin inserta: *filamenta* complanata, glabra: *antheræ* obtusæ, introrsæ, biloculares, basi insertæ: *loculis* parallelis, longitudinaliter dehiscentibus. *Ovarium* liberum, globosum, uniloculare, villosissimum. *Stylus* teres, glaber. *Stigma* parvum, truncatum, pruinosum. *Capsula* unilocularis, bivalvis, polysperma, apice dehiscens: *valvis* sublignosis, concavis, medio placentiferis. *Placentæ* nunc demùm solutæ, basi connatæ. *Semina* parva, angulata, atrofusca, adscendentia, hinc convexa, inde planiuscula, apice alâ exiguâ cristata, basi umbilico prominenti instructa; *testa exterior* crustacea, superficie reticulatâ; *interior* membranacea, pallidior: *albumen* nullum. *Embryo* erectus, teres, lacteus: *radiculâ* cotyledonibus semicylindricis parùm longiore, obtusâ, centrifugâ.

Frutices (Peruviani) *pubescentiâ fasciculatâ cinereo-tomentosi.* Folia *opposita, petiolata, exstipulata, simplicia, crenata.* Flores *racemosi.* Pedicelli *uniflori, bracteâ suffulti, solitarii v. fasciculati.*

1. *rugosa*, foliis suprà rugosis, antheris oblongis: connectivo dilatato!

Abatia rugosa, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 136. *Gen.* t. 14. *Fl. Peruv. et. Chil.* tom. 5. ined. t. 463.

Hab. in Peruviæ collibus frigidis ad Rondos, Pillao, et Nauyan.—*Ruiz et Pavon.* ♄. Floret a Maio ad Octobrem. *Vulgò* in Pillao Taucca-Taucca, id est, Acervus-Acervus. (V. s. sp. in Herb. Lamb.)

2. A *parviflora*, foliis suprà planis, antheris subrotundis: connectivo angustissimo.

Abatia parviflora, *Ruiz et Pavon* l. c. 1. p. 136. *Fl. Peruv. et Chil.* tom. 5. ined. t. 464.

Hab. in Peruviæ runcationibus circa Muna vicum.—*Ruiz et Pavon.* ♄. Floret a Maio ad Augustum. *Vulgò* Taucca-Taucca. (V. s. sp. in Herb. Lam.)

Folia magis canescentia, suprà planiora. *Flores* duplò minores. *Laciniæ calycinæ* ovato-oblongæ. Situs racemorum in utraque idem. Species Bogotensis ab amicissimo Kunthio descripta videtur distincta.

Obs. Stamina quadruplum laciniarum calycinarum efficiunt, sed modo unusitato in simplici ordine disposita. Pili faucis ob formæ structuræque differentiam vix pro staminibus sterilibus desumpti.

There is another genus, which M. De Candolle has placed in *Homalinæ*, namely *Aristotelea*, on which I beg to offer a few observations. The comparison of this genus with *Tricuspidaria* leaves no doubt of its being a legitimate member of the family *Elæocarpeæ*. In both genera the calyx is five-lobed; the petals five, and alternating with the lobes of the calyx; the stamens are inserted in the calyx; the anthers long, and opening at the top by two fissures; the leaves in both are generally opposite, of precisely the same structure, serrated at the margin, and furnished with innumerable minute pellucid dots; the stipules are small and deciduous; the fruit in both is three-celled; and the flowers are white and pendulous. The structure of the seeds in both genera is precisely similar, having a flat embryo placed in the centre of very copious fleshy albumen. The stigmata in *Tricuspidaria* are distinct, but united in *Aristotelea,* which has been hitherto considered as possessing a simple stigma. The leaves may more correctly be regarded as approximated in pairs than as decidedly opposite, and they are found often alternate, as might be expected, in both genera.

(To be concluded in our next.)

New Observations on the Blood-like Phenomena observed in Egypt, Arabia, and Siberia, with a View and Critique of the Early Accounts of Similar Appearances. By Mr C. G. Ehrenberg.

The blood-red colour of waters, and the scattered blood-coloured spots which have sometimes appeared so suddenly as to excite the wonder, and often the alarm, of the people of all ages, however much the scientific investigations of these things may have been gradually refined and confirmed, are still objects of much ambiguity; and, even among learned men, the knowledge of the causes of this phenomenon is capable of farther extension, and of stricter demonstration. In my travels, I have had an opportunity of collecting many facts regarding these appearances, that is, on the red colour of the Red Sea, on the blood spots in Egypt; and, during the last journey which I, in company with Baron Humboldt, made to Siberia, on a very intense blood colour in a lake of the Steppe of Platow. I shall attempt to arrange these facts along with the appearances already known, so as to counteract the present disposition, created by Chladni, to refer all the historical accounts of blood-coloured masses to meteoric and cosmical appearances. As it is of consequence to distinguish, by the most accurate investigation, the appearances of this kind, which are indisputably meteoric; so, on the other hand, for the sake of comparison, it must be of consequence to know the genuine characteristics of such appearances as are not meteoric; and, although Chladni was so much inclined to enlarge his catalogue of meteoric masses by including in it bloodlike appearances on the earth's surface, it is no easy matter to prove that even a single one of his examples are really meteoric.

The explanation of the appearances of blood is historically divided into four periods, which may be called, 1*st*, The theocratic or period of miracles; 2*d*, The period of the Hippocratic school; 3*d*, The physical or natural-historical; and, 4*th*, The atmospherical or cosmical.

The first period extends from the commencement of history till the time of Cicero. In the second, the admissibility of miracles was questioned, and a belief in a crude and boiled condition of atmospherical and terrestrial moisture was prevalent. Peiresc of Aix commenced the third period; and Chladni, who strongly reprehended the encroachments of natural historians in these matters, established the fourth.

We have the most ancient account of blood-coloured water from Egypt, in the books of Moses. That was an immediate operation of the Almighty, and one of the miracles which Moses performed in the presence of Pharaoh. The Nile was red, and stank; the fishes died, and all the water in Egypt was changed in the same manner *.

After this, the poems of Homer mention the earliest appearance of a similar kind, or the poet took advantage of, at least repeated, the natural appearance of blood rain, known at that

* Exodus, chap vii. ver. 19.—And the Lord spake unto Moses, Say unto Aaron, Take thy rod, and stretch out thine hand upon the waters of Egypt, upon their streams, upon their rivers, and upon their ponds, and upon all their pools of water, that they may become blood; and *that* there may be blood throughout all the land of Egypt, both in *vessels of* wood, and in *vessels of* stone. Verse 20. And Moses and Aaron did so, as the Lord commanded: and he lift up the rod, and smote the waters that *were* in the river, in the sight of Pharaoh, and in the sight of his servants; and all the waters that *were* in the river were turned to blood. Verse 21. And the fish that *was* in the river died; and the river stank, and the Egyptians could not drink of the water of the river; and there was blood throughout all the land of Egypt.

time, for the purpose of enlivening his poetical representations, and considered it as a direct encroachment of the gods on the established laws of nature.

If the Red Sea really has its name from the colour, this would be the third historical notice, and is to be placed after that of Homer; but the old Jewish records do not call the Arabian Gulf the Red Sea; and it is called so only by the later translators of them from the Alexandrian. I have myself observed and examined the periodical appearance of blood-red sea-water in the Red Sea, and shall here briefly explain myself, but in another place more circumstantially.

This appearance is also frequently mentioned in the Greek and Roman classics; and, till those times, these phenomena were generally considered as immediate operations of supernatural power, and violations of the established laws of nature. Cicero was perhaps historically the first who expressed his doubts regarding the preternaturality of the appearances of blood at that time, and attempted to connect these appearances with physical phenomena, by directing his attention to the error of confounding the expresss traces of blood, and of the bloody colouring of moisture; and he found the latter to depend on a mixture of coloured earthy ingredients.

From this time till the commencement of the seventeenth century, historians have recorded many such natural phenomena, though we cannot discover that any one has taken the trouble of comprehensively and accurately investigating cases of this kind. The Hippocratic school gave an absurd explanation; thus the physician Garcæus, in 1568, says, blood-rain is rain boiled by the sun, and compared it with red urine in fever.

To introduce into this article Chladni's important aim of advancing the knowledge of truly cosmical and atmospherical bodies, it may be of advantage to bring together the notices he collected of appearances of blood, previous to the commencement of the seventeenth century, according to the following scheme, in which I take advantage not only of the work of Chladni, but also of the spirited labours of Nees von Esenbeck, to which I make some additions of my own.

I. Rivers flowed suddenly with red or bloody water, *without any previous rain of that colour.*

In 323 A. C. in Picenum; in 787 P. C. in Italy.

As no account is given of the locality of these rivers, it is doubtful whether both these instances may not be referred to the third rubric. Similar doubts exist regarding modern instances of this kind. Accurate investigations are every where awanting.

II. Lakes and stagnant waters were suddenly or gradually coloured, *without previous blood-rain.*

Two such cases are found among the notices of early periods, collected by Chladni.

The bloody colour of the Volsinian Lake, in 208 A. C., recorded by Livy.

The similar colour of a Venetian lake, in summer of the year 586 A. C. I find in Pliny, that there was a lake near Babylon, which had a red colour during eleven days of summer.

The colouring of Lake Wan, in A. D. 1110, may perhaps belong to this department, though it was considered to be caused by a fiery meteor falling into it.

Every appearance of this kind requires rigid examination, in regard to the very small cryptogamous plants, which, singly, are imperceptible to the naked eye, and whose colouring is visible only when a great many of them are together, and also in regard to equally minute water animalcula. As the foregoing instances were not examined in these respects, they cannot with certainty, nay, even with probability, be considered as atmospherical productions.

III. Meteoric substances, which are usually colourless, dew, rain, snow, hail, and what are called shot stars, fall from the air red coloured, as blood-dew, blood-rain, and clotted blood, *without the atmosphere being obscured by red dust.*

(*a*) Blood-dew.

To this belong the two passages of Homer, which, however poetical, are still applicable to rain, and some accounts of bloody sweat on the statues of the gods, and on warlike armour, which I find mentioned in Livy.

The want of accurate investigation of the cases mentioned, along with the predilection, in every age, for the marvellous, induce us rather to direct our attention to the red excrement of insects, than to local atmospherical depositions, so rare in our time.

(*b*) Blood-rains, by which rivers simultaneously do or do not assume a red colour.

Appearances of this description have at all times been abundantly observed, but very erroneously investigated. Many accounts of this kind have been related as prodigies in the Roman History, before Christ. Dio Cassius, in particular, considers that the blood-rain which fell in Egypt, in the time of Octavian, must be recorded as a thing very remarkable, because it never rained in Egypt, which is a mistake.

In the year A. D. 65, during the reign of Nero, blood-rain fell, which tinged the rivers with a red colour.

Two instances are recorded of blood-rain in the sixth century. In the eleventh century, one; in the twelfth, two; in the thirteenth, one; in the fourteenth, two; in the fifteenth, one; and in the sixteenth, five.

The chief difficulty in deciding these single instances, lies in this,—that the circumstances under which they happened are not related. Whether it rained from clouds or without clouds, whether the rain was intentionally caught, and thus proved to have fallen from the atmosphere; or whether, from red spots that were seen without or after rain, on objects of different kinds; they merely concluded them to be drops of rain that had fallen. The accounts are so brief and inconclusive, sometimes accompanied with superstitious and manifestly false additions, that we may venture to refer the cases to terrestrial phenomena quite within our reach. Whoever reflects how strange and trivial the cause of popular alarm is, in regard to any thing marvellous, may well hesitate in his inclination to draw any conclusive theory from such cases. Since Peiresc, during a public alarm at Aix, directed his attention to them, every body knows that bees and butterflies, the one while extricating themselves from the pupa, the other in their first flying forth in spring, or after a long continuance of bad weather, let fall many drops of a red fluid, often in surprising quantities, and storms uniformly favour the extrication of butterflies. Though single instances may belong to the class of atmospheric phenomena, it is highly probable that others may be referred to the facts just stated; and, as regards the former, there must always be, from a want of circumstantiality in the relation, a doubt whether they happened without red atmospherical dust, and do not perhaps belong to the fourth rubric.

(*c*) Red snow and hail have been observed only in modern times. The latter is unquestionably atmospherical, but opinion is divided as to the former. They are not of a blood colour, and may be easily referred to the fourth rubric.

(*d*) Blood-jelly.

Red gelatinous matter, like coagulated blood, scattered on the surface of the earth in spots or masses.

Four instances of this kind have been recorded. The blood-rain at Balch, in 860; at Lucerne, in 1406; in Mannsfeld, in 1548; in Schlage, in Pomerania, in 1557.

These cases were first observed some time after they were believed to have fallen from the atmosphere upon the earth; and it hence remains doubtful whether they were ever in the atmosphere. Meteoric stones, indeed, suggest indications of atmospherical formation, but these gelatinous masses point out no indications of the kind. Indeed botanists themselves are at variance with philosophers about the matter of shot-stars, which is commonly colourless, and the Tremella meteorica, which Meyen recently described as Actinomyce, may be readily taken for a shot-star, if both are generally capable of being discriminated. It may be conceived that this is not necessary, and that the meteoric mass might assume the organic and vegetable structure. To this it may be objected, that the specimens of Tremella meteorica, are frequently found of different sizes, without it being probable that they are remains of a shot-star, especially where they are small, and, as is commonly the case, occur attached to animal bodies, and even incorporated with them. It is therefore improbable that it is sometimes formed terrestrially and sometimes meteorically, because the body exhibits too little characteristic peculiarity to owe its origin to circumstances so very dissimilar. Besides, this supposes that the sudden origin of organic bodies from unorganized materials may be proved.

As to the two cases of Lucerne and Mannsfeld, it is to be remembered, that, in the latter case, the blood-spots found on the soil, on the morning after the appearance and explosion of a fire-ball, admit of a very simple explanation, that, in searching for something extraordinary, as the sign of a mass that had fallen, another fungus was found, the Telephora sanguinea, which Agardh calls Palmella cruenta; and which, on account of its entirely superficial extension on moist ground, and from its striking colour, exhibited completely the appearance of spots of blood.

The thick gelatinous masses of both the other cases is distinguished from the usual matter of shot-stars, the Tremella meteorica, by their red colour. It would therefore be of importance to examine whether similar appearances are any thing else than this, with a particular difference of colour; whether they are definitely marked by a peculiar structure; or whether, in the absence of any structure, it can be perceived to be an inorganic meteoric concrement,—a matter hitherto undecided.

These considerations do not indeed account for every case, but may contribute to a comprehensive conception of such appearances, a multitude of uncertain accounts being of no value; while single cases, rigidly investigated, give a distinct and satisfactory form to their connection.

IV. The atmosphere is loaded with red dust, by which the rain accidentally assumes the appearance of blood-rain, in consequence of which rivers and stagnant waters appear of a red colour.

This red dust has been five times observed, viz. 1. In the time of the Emperor Michael III. at Brixen, 869 A. D.; 2. At Bagdat, 929 A. D.; 3. In the Crusades, 1096 A. D.; 4. By a meteor falling into the Lake Van, 1110 A. D.; 5. At Rome, during the blood-rain which fell at Viterbo, 1222 A. D.

This kind of appearance belongs more probably to inorganic than to organic nature; and it is to be regretted that the accounts are so very unsatisfactory.

So much for animadversion on the meritorious Chladni's collected accounts of meteors from ancient times till the seventeenth century.

As has been already observed, Peiresc of Aix was very much celebrated, in his time, for his various knowledge, he being the first who, at the commencement of the seventeenth century, by judicious investigation, removed a great portion of the superstition and error which existed regarding the appearances of blood. When, in the year 1608, what was supposed to be a shower of blood, gave great alarm to the inhabitants of Aix, in France, and the clergy increased the alarm, Peiresc took the trouble of searching out the real cause of the appearance, when he found that butterflies, which at that time appeared in vast numbers, after their escape from their pupa tegument, let fall some drops of a red liquid, which caused the bloody spots. As these spots were observed in covered places, not accessible to rain, but accessible to butterflies, there can be no doubt about the correct conception and explanation of the phenomenon, and a comparison of similar and earlier accounts affords the satisfactory result, that they also happened at a season of the year that countenances this explanation. The observation of Peiresc has lately found its way into all schools and compendiums; and hence arose the erroneous opinion of less observant philosophers, that every appearance of blood-rain was caused by the sloughing of insects.

In the middle of the same century, Swammerdam (who died in 1685), in a journey near Vincennes, in France, saw a kind of bloody water, at the sight of which he was astonished. He was naturally led to examine it more minutely, when he found that it was coloured by innumerable multitudes of small red water-fleas (Daphnia pulex); and, on this occasion, related that an appearance, which owed its origin to the same cause, and which greatly alarmed the inhabitants of Leyden, had been observed and known by the professor of medicine, M. Schuyl. Bibl. der Natur. s. 40.

In the eighteenth century, the knowledge of these appearances has been extended by similar careful investigations. Romberg, Dr Westphal of Delitzch, the missionary Gonsay, who was in California in 1746, Linnæus, De Saussure, Girod Chantran, and others, have partly become the inventors of new methods of explanation, partly the influential corroborators and promoters of the mode of explanation already known. In 1700, Romberg observed a shower of blood, that excited universal attention, and which he could the more satisfactorily show to be produced by the first flying forth, and the casting of bees, the more evidently that the phenomenon in the place around the bee-hives themselves was remarkably striking.

In 1711, the Rev. Mr Hildebrandt found insects in red rain-water, at Orsiœ, in Sweden.

In 1716, Dr Westphal, of Delitzch, observed red spots on the leaves of plants at Grafenhainchen, not far from Delitzch and Wittenberg. He was not inclined to consider them the production of insects, but real red dew, coloured by a combination of sulphur.

The missionary Gonsag, by observation in 1746, brought forward a new method of explaining the appearance of red water, which Klaproth introduced, but seems to have misunderstood it. According to the Spanish original, Gonsag saw at California, hot springs in the sea, which were visible at the ebb of the tide, but covered at full flood by the sea. During full tide, the sea at that place appeared, to the extent of two miles and a half, of a bluish-red colour. Here there was evidently a chemical operation of the sea-water mingling with the spring-water.

Linnæus also observed, that water, with a red colour like blood, may be produced by an immense increase of small red aquatic animals, which he, with Swammerdam, takes to be the Monoculus pulex. Agardh, however, has recently dissented from this opinion, believing the animal to be the Cyclops quadricornis, which is a similar, but yet a very different animal, and which he himself observed in Sweden, under similar circumstances; while the Monoculus pulex is never of a lively red colour. Schœffer, in his Treatise on the Water-flea (s. 53), takes it for the Monoculus pulex; therefore both animals must be referred to, as it is not to be supposed that a number of naturalists, of close observation, should have committed the same error. I have never myself, indeed, had an opportunity of seeing the Monoculus (Daphnia) pulex of a lively red colour, though I have yearly observed blood-red marsh-water coloured by the Cyclops.—Agardh, Nov. Act. Nat. Cur. xii. 2, p. 738.

Linnæus also, in his journey through West Gotha, appears to have first observed the colouring substance, which, in red snow, has recently caused so much investigation.

As the red rain at Brussels in 1646 had been tested by a distillation of the water, Dr Thomas Rau, in the same manner, made chemical experiments on the bloody rain-water at Ulm, of 15th November 1755. He indeed believed that the then favourite mechanical mixture of sulphur with water might be inferred from his experiments; but, from them, it is more probable that the colour was caused by organic corpuscula in the water. Both cases appear very similar, and, by a more rigid and comprehensive investigation, might have afforded a very different result.—Nov. Act. Nat. Cur. ii. p. 85, *seq.*

The blood-rain at Lucarno, in the south of Switzerland, of 14th October 1755, was connected with red atmospheric dust, and is hence of great importance to Meteorology.—*Ibid.*

At the same time there fell remarkable blood-coloured water, caused by volcanic operations. The springs near the city of Mequinez, west of Fez, after a great volcanic explosion, flowed alternately with red coloured water.—*Ibid.* p. 90.

In seamen's journals that treat of appearances of blood in sea-water, we must take into consideration the possibility of very large marine animals actually shedding blood, that may colour a calm sea to a considerable extent. Johnson, de Piscibus, takes notice of this appearance in a unicorn fish, whence it is quoted by Baeck, in his treatise on the sword-fish (Istiophorus).—Acta. Nat. Cur. viii. p. 212.

De Saussure, in 1760, first examined, chemically, the colouring matter of the red snow, and found it to be a vegetable mass, on which account he was erroneously inclined to take it for the pollen of flowers.—Voyage dans les Alpes, ii. § 646.

Towards the conclusion of the 18th century, observers witnessed other causes of blood colours. In 1790, a pond at Giebichenstein, not far from Halle, exhibited a blood-red colour. On this occasion Weber observed that the colour was caused by very small microscopic animals, whose figure resembles that of Müller's Cercaria viridis.—Wagner, Naturkunde & Ländermerkw. 1. Th. p. 143.

In 1797 Girod Chantran, who observed an entirely similar appearance in France, examined it more accurately, and thereby opened a new field for investigation. He observed the water of a pond to be of a brilliant red colour (rouge eclatant), the shade of which was between cinnabar and carmine. It fortunately occurred to him, not only to prove the colour of the water chemically, but also to observe it with the microscope; and, as Weber discovered, he found that the cause of the colour was, in animalculæ, not visible to the naked eye. He took them for a species of the volvox, having some affinity to the Volvox globator, but still very different. These are the first facts by which we are informed that real infusoria could, in early times, cause alarm among whole districts and communities. Girod Chantran attempted to colour the magnified delineations of these animalculæ with their own bodies, using them as a pigment, and was so enthusiastic about the beautiful and vivid colour, that he recommended the preparation of them as a very lucrative speculation, proposing that artificial lakes should be formed, capable of being dried at pleasure, to obtain the valuable colouring matter. No one had before raised the infusoria to so high a political value. He calls this red infusory animal Volvox lacustris, but has not described it more minutely.—Bullet. des. Sc. Nat. de la Soc. Philomatique. a. 6.

As every department of science has made great progress in the 19th century, the knowledge of these appearances, and of their various causes, has been greatly extended.

Persoon examined a matter entirely similar to coagulated blood, that appeared on damp soil on road sides, and found that it had a vegetable structure, and belonged to the species of mushroom called Thelephora, on which account he, in 1801, described it under the name of Thelephora sanguinea. Fries has lately joined it with the (Thelephora) Phylacteria crustacea, and Agardh has more recently described it as an Alga, under the name Palmella cruenta.

The reddish salt-beds which Andreossy observed in the natron lakes of Upper Egypt, are not so closely related to these appearances, though I find them brought forward by Linck as an instance of blood-red water. In my journey with Humboldt, I saw a similar rose-red colour in the salt lake Elton, in the steppe of Astracan; it did not apparently belong to the water, but to the salt, and faded on being dried.—Descr. de l'Eq. H. Etat. Moderne, t. i. p. 279; Linck, Phys. Erdbeschreib. 1. s. 328.

Science, in this respect, received very important additions in 1815, when an appearance of this kind in a lake near to Lubotin, in the south of Prussia, excited the attention of the people. Red, violet or grass-green spots were observed in the lake. It was the end of harvest. In winter the ice was coloured with it three lines in thickness on the surface, while beneath it was colourless. The inhabitants in the neighbourhood, like the Greeks in Homer, and the Arabians at Kaswini, prognosticated great misfortunes from the appearance. It fortunately happened during the active labours of the chemist Klaproth, who took an opportunity of ascertaining the chemical ingredients of the colour. He found that an albuminous vegetable matter, with a particular colouring matter very similar to indigo, produced the appearance, and concluded the decomposition of vegetables in harvest to be the cause of the appearance, which could therefore only take place in harvest. The transition of colour, from green to violet and red, Klaproth explained by the absorption of more or less oxygen. This fact shows how a chemist of accurate observation may be able to discern the real nature of organic matter, and where the investigations of the botanist must cease. It is very probable, that, in locality and position, a botanist, practised in the examination of microscopic bodies, would not have discovered decayed vegetable matter, but perfect vegetables. The transportation of the water to Berlin in close vessels, must indeed have entirely destroyed them, and their colour may thereby have mingled more intimately with the water. Scoresby mentions that, in 1820, he observed the water of the Greenland sea striped alternately with green and blue, and that the particular colours were produced by small animalculæ. He reckoned in a single drop of water 26,450 animalcules; hence reckoning 60 drops to a drachm, there would be in a gallon a number one half of the population of the globe. This coloured water, to an extent of 6° of latitude, formed one-fourth of the surface of the Greenland sea. The animalculæ observed by Scoresby, were small medusa-like creatures, from one-third to two-thirds of a line in length. The water had the smell of oysters.—Scoresby's Acc. of the

Arctic Regions, vol. i. This observation does not indeed immediately belong to the bloody colour of water; but, as it clearly indicates the abundance of microscopic organization in the sea, it was thought advisable to attend to it.

Though a variety of observations had been made at an earlier period on red snow, the voyage of the English Captain Ross in 1818 and 1820, afforded particular facilities for a varied and fundamental examination of this subject. The red mountains in Baffin's Bay, of 6 English miles long and 600 feet high, showed that their colour was caused by large flakes of red snow scattered upon them; and this phenomenon has not merely been noticed, but the colouring substance has been collected for examination. It was at first taken for birds' mute. Francis Bauer, a microscopic and botanical investigator, and the chemists Wollaston and Thenard, kept the substance for examination. Robert Brown, Hooker, Sprengel, Agardh, De Candolle, and Chladni, have given their opinions concerning it, and, more recently, many other naturalists and philosophers. All, with the exception of Chladni, agree that the colouring matter is a vegetable substance; and botanists unanimously declare it to be not a decomposed dead substance, but a living vegetable organization. It has been variously arranged by authors, hence have arisen the following synonyms for the colouring body. Is the *Uredo nivalis* of Bauer a genus of Alga? By what affinity is it connected with the Confervis simplicissimis, and the Tremella cruenta? Robert Brown: *Palmella nivalis*, Hooker: *Lepraria kermesina*, Wrangel: *Protococcus kermesinus*, Agardh: *Chlorococcum*, Fries: Vaucheriæ radicatæ affinis, Sprengel: Alga, Ulvis et Nostoc affinis, De Candolle: *Sphærella nivalis*, Sommerfield: *Protococcus nivalis*, Agardh. The last mentioned name must be distinguished from that of the more complicated Protococcus nivalis, which Greville received from Captain Carmichael from the shores of the island of Lismore, which Agardh considers as an entirely genus, and calls it Hæmatacoccus Grevillii.

We cannot admit the phantastic opinions, that these bodies are formed in the snow through the influence of the solar rays, but consider them as foreign bodies brought from another situation and deposited on the snow, and, by the melting of which, they collect in masses, and thus produce the red-coloured patches.

In melting snow, we in general observe, every year, that although it appears dazzlingly white before it melts, yet it may soon be perceived during its melting, to disclose traces of dust which has been mixed with it by the motion of the atmosphere, and which gradually assumes a darker earthy hue, and at length produces a spotted black surface. It is very probable that the snow-plant, during sunshine, may still farther develope itself and increase.

Most botanists agree in this, that these bodies belong to a kind of Alga. Bauer alone says that they are of a mushroom form, of the genus Uredo; and Wrangel, that they are of the lichen form, of the genus Lepraria. The observations of Wrangel are too convincing to be overlooked. Agardh has looked upon the matter in the same light; but it appears to me that with these must be conjoined the observations of the Prior Biselx of St Bernhard, Charpentier, Meisner and Chladni, and which throw into the back ground the doctrine of equivocal generation. The idea of infusory animals is to be entirely rejected.

The preservation of these red bodies in snow-water for the space of five years, according to the testimony of Agardh, seems to me opposed to the nature of alga, and would rather prove that they are bodies which do not belong to the element of algæ, and which do not develope themselves in it. As land vegetables, they belong either to the lichen or the mushroom. The simplicity of the structure ranks them closely with the mushrooms, and no good reason appears why they may not be denominated Lepraria nivalis. In my Silvis Mycologicis I proposed this arrangement, and I have, after frequent repeated observation, still the same idea.

At the commencement of the year 1819, Chladni wrote his celebrated work on fiery meteors, which I here particularly refer to. He was at that time acquainted with the chemical analysis of the substance in Thomson's Annals of Philosophy, January 1819, and with Bauer's botanical explanation of the colouring body. The former, which proceeded from the conjecture that the substance might be bird's mute, to which the experiments were always directed, but which terminated in the result that it was a vegetable mass, and probably a cryptogamous plant, had irritated Chladni to such a degree, that he complained, sect. 383, of the valuable meteoric dust being thus wasted by the absurd interference of chemists. In sect. 385, he says that chemists and physicians pretend to know the qualities and origin of this material better than naturalists.

(*To be concluded in next Number.*)

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*Observations on the Greenland Sea as connected with the late Disasters in Baffin's Bay**. By THOMAS LATTA, M. D., Member of the Wernerian Society, with a Map. Communicated by the Author.

IT is only thirteen years since the higher latitudes of Baffin's Bay have become famous in the annals of the whale-fishery, and, during that short period, no less than seventy sail, employed by our own countrymen in that trade, have been destroyed, causing not only a national loss in the destruction of much valuable property, but great misery to the numerous families who were dependent on the success of the various enterprises. The frequency of these disasters may be considered as a sufficient apology for our presuming to suggest such means as may tend to diminish the chance of their recurrence. It is true we cannot form any plan, consistent with the prosperity of the voyage, by which the dangers may be entirely averted, because these, for the most part, depend on the movements of the ice, which are very irregular, being controlled by every wind that blows; yet, on viewing the peculiarities of the track pursued by the navigator, and considering the changes effected in these by the advances of the season, we may be able to propose some changes, calculated to diminish the risks inseparable from the present system.

* Dr Latta having visited the Greenland Seas, as our readers will recollect from his former papers in this Journal, his observations may be received as those of one experienced in the nature of arctic regions.


Map shewing the distribution of the Ice in Davis Straits and Baffins Bay with the Routes of the Whale Fishers.
Blue colour represents open Sea
Brown Do Land
White Do Ice as it apears in general in the month of Augt & Sept
Lancasters Sound
Arctic Highlands
Melville Bay
Devil's Thumb
Pr Williams Land
Direction of Current also of Whales in Sept
Land Ice
Prevailing Wind in Summer
Greenland
BAFFINS BAY
West Land
N East Bay
Disco
Home Bay
Capt Ross last seen here with foremast sprung Augt 1829.
Coast loaded with bergs aground and drift ice
Wide ford
Arctic Circle
Mt Raliegh
Fox Channel
Davis Straits
Course of Whalers
Godhaab
Navigable in August
Hudsons Straits
Iceberg
Iceberg
Cape Farewell
Ungava bay
Labrador
Heavy Washed ice
S. West Fishing Station
Iceberg
110
100
90
80
70
60
50
40
30
20
10
75
70
65
60
55
70
65
60
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In the history of the whale-fishery, there are mentioned three different quarters in and adjoining Baffin's Bay, which are visited for the capture of whales. The *first* of these lies along the east side of the bay, extending from the entrance of Davis' Straits northward by Disco, to about the 73d parallel of latitude. The southern half of this tract is generally open early in the season; whilst its more northern extremity is seldom navigable till late in July, and is even then very hazardous. It was in former years numerously frequented by whales, but is now entirely deserted by them. The *second* station, usually called the "South-west Fishing-ground," lies along the coast of Labrador, and about the entrance of Hudson's Straits. Though this, from its position, is accessible at all times, yet the whale-fishery is prosecuted there under many disadvantages, and not a few dangers; for not only have the whales become very scarce, but they are to be seen only in spring, when the weather is extremely cold, and the nights long and dark, and are to be pursued occasionally among heavy-washed lumps of ice, exposed to all the fury of the waves from the Atlantic. This station was the chief source whence blubber was derived this season. Fishermen, however, seldom do more than call at this quarter on their way northward. Indeed, during the present season, some of our most enterprising fishermen considered such a visit as a waste of time, and, on doubling Cape Farewell, took their course directly northward. From the scarcity of "fish" on the coast of Labrador, and the absence of them along the eastern shores of Baffin's Bay, whale-hunters are now constrained to seek their prey in higher latitudes, pursuing it even to the regions adjoining Lancaster Sound, which is the *third* station we have to notice. Whales are found there in great abundance, but they are yearly becoming more scarce, and much more shy than when first fished. Though this station was discovered by Baffin upwards of 200 years ago, it did not become famous for its whales till 1817, when Mr Muirhead, master of the Larkins of Borrowstounness, penetrated these unfrequented regions. Encouraged by a "clean ship" and a navigable sea, he sailed northward, at what, in those days, was considered a late season,—the beginning of August, much to the terror of the crew, who, nevertheless, filled the ship with blubber in ten days! In the following year (1818) the Discovery Ships, commanded by Captain Ross, penetrated the deeper parts of Baffin's Bay, and found them swarming with whales. Since that discovery this fishing-ground has been annually resorted to by our whalers, notwithstanding the manyfold perils of the voyage, of which we shall now endeavour to give a general view.

The whaler of the present day generally reaches the ice at the entrance of Davis' Straits about the end of March or beginning of April, amidst fogs and tempests, extreme cold, and long dark nights. He immediately commences his search after whales, hoping to find them in their ancient haunts, but seldom meeting with any thing to encourage his delay; he, through the injudicious orders of his employers, or his own misguided zeal, immediately stretches northward towards the regions where whales are abundant. Two routes lead thither, the one along the eastern, the other along the western side of Baffin's Bay, the sea in the middle being, at this early season, totally unnavigable, from the vast quantity of ice formed during winter. Being aware of the great advantage of an unimpeded western passage, his first business is to seek it out. There the sea is sometimes opened by the south-west wind, which, as in the Spitzbergen seas, prevails during spring and summer, driving the ice off the land. He very seldom succeeds so early in the season, and in the attempt is in great hazard of being "beset," for unless the wind prevents it, he will always find the western shores of the sea, in the frozen regions, more hampered with ice than the eastern. Besides, the irregularities of the coast of the west land, and the course of the great southerly current, which is only sensibly felt there, are very inimical to such an attempt. From *Home Bay*, in Latitude 68° N., down to the *Arctic Circle*, the land stretches out into the bay, forming a promontory, which is opposed to the course of the current. This promontory, assisted by the many icebergs stranded on its shallows, arrests the drifting ice, to the hinderance of the navigator's farther progress, who, anxious to reach the waters where whales abound, is induced to try the more dangerous eastern passage, which, though pregnant throughout with difficulties, does not become eminently perilous until he gets beyond what constituted the northern limits of the station frequented by the old fishermen, who had always a superstitious dread of the latitude of The *Devil's Thumb.* Beyond this he has daily to contend with increasing dangers, compared with which the hazards of the Spitzbergen fishery are very insignificant, and, as he nears Melville Bay, he gets into a region, bearing both on sea and land, the most frightful impress of the terrible power of the dismal winter in those forlorn regions. Throughout several hundred miles of coast, the soil is buried under mountains of ice, which must have been accumulating for ages; the seaward limits of this tract terminate in a terrible precipice, from one to two thousand feet high, fragments from which, weighing thousands of millions of tons, constitute the icebergs seen drifting about in the sea, and often aground in water some hundred of fathoms deep. From the cavernous base of this frozen shore, an icy plain in many places takes its origin, stretching ten or twenty leagues out to sea, retaining its site unmoved, till subdued by the warmth of advancing summer. Field-ice of this description, studded with icebergs aground, which assist in its formation, is common on the shores of Baffin's Bay, and the coast of Old Greenland, whence it is called "*Land Ice,*" to distinguish it from the fields, floes, icebergs, &c., which are seen drifting about in the sea, and are called "*Sea-Ice.*" The former is fixed, the latter is detached, differences on which depends the possibility of navigating these regions in spring, for all along the eastern shore, unless prevented by adverse winds, the separated ice recedes from that which is fixed; thus, a channel is formed along the seaward limits of the land portion, increasing in width as the ice is dissolved. It is through this channel that the whale-fisher pushes his way northward; but, in early months, the ice continuing uninfluenced by the season, this opening is at best but narrow, often partially obstructed, affording only a tedious and intricate navigation; frequently it is entirely obliterated, causing a most irksome detention for weeks, and even months. Nor, is this all, for in proportion to the strength of the gale, so is the force with which the ice is hurried towards the shore, then the situation of the mariner caught in the drift becomes one of extreme anxiety. While yet a little "open water" remains, he seeks the lee of some iceberg aground, or some creek in the margin of the land-ice, or of the big field or floe which drifts down upon him, into which he may thrust his ship. If no situation is found, the crew ply their ice-saws, and cut out a dock, where they may safely remain till the ice recedes. Such a situation in the land-ice, if it is sufficiently strong, is preferable, being free from the revolving movements of the detached masses. Often, however, their labour is unavailing, their retreat, obtained by so much exertion, being unable to sustain the tremendous pressure, is rent in pieces, and the ship it contains destroyed. Melville Bay, the vortex in which our ships are usually engulfed, is very formidable, on account of the occurrence there of such phenomena. It is quite unsheltered from the prevailing winds of the season, which fill it with the ice of the neighbouring sea; it is at the same time protected by the form of the land, from the influence of the currents, which, in the open sea and along the western shores, are ever in operation, carrying off the ice to the southward. In this bay, hopeless indeed is the case of the ship, pent up among accumulating ice, and caught by the tempest. Seamanship is utterly unavailing, the destruction of the stoutest ship is the work of a moment, and the crew is abandoned to all the miseries of a fearful climate and a snow-covered region.

It was in this bay that the Isabella and Alexander, discovery ships, were frequently in great jeopardy. Particularly, on one occasion, during a south-westerly gale, the ice was forced in upon the ships with such violence, that every support threatened to give way. The beams in the hold began to bend, the iron tanks settled together, and the Isabella was lifted up several feet; fortunately the ice receded, and she was liberated; but so violent was the gale, that her anchors and cables broke one after another, and she ran foul of the Alexander with a tremendous crash, breaking anchors and tearing away their chain-plates. In this dilemma, they perceived a field of ice bearing down on them, and a reef of icebergs fast aground on the lee. They endeavoured to saw docks in the field, but fortunately it was too thick for their longest saws, for the ships had scarce escaped when the part of the field chosen for the dock came in contact with a berg with such violence, that, notwithstanding its great thickness, it rose more than fifty feet up the icy precipice, then suddenly broke, the elevated part tumbling back with a tremendous crash, and overwhelming with its ruins the very spot previously chosen for safety.

During the present season, our whaling fleet encountered unparalled disasters in this bay. The storm blew furiously from the south, driving before it congregated fields, floes and icebergs. The mariner viewed the coming evil with dismay, and placed his frail bark in the ice-haven he had cut in the field that was fixed on his lee, beneath the further verge of which the waves lay in slumber in the dark icy caves that skirt Melville Bay. The ice was urged onward in wild disorder, with fearful grinding noises, until the frozen masses coalescing, the pressure became so great as to overcome every resistance. In the midst of such agitations, many an unfortunate whaler was destroyed: some were fairly pressed out of the water, the ice piercing their sides, then recoiling, the vessel sank into the deep. One ship was pushed under the bottom of another, yet they both righted when the pressure subsided. In another case, the ship was thrown on her beam ends, and the field in motion went right over her—she was abandoned as a wreck, and, according to the laws for regulating the whale-fishery, became the property of any one. A gang of plunderers sawed her out, and, in defiance of the authority of their masters, possessed themselves of the rum casks. They revelled in all the glories of inebriation, in defiance of the rigour of a Greenland climate, until an end was put to the strange scene by a change of weather and want of rum.

There can be little doubt that Melville Bay is never free from ice; nay, it is highly probable that it is at all seasons as much incumbered with it as any quarter of Baffin's Bay—a supposition which is not only favoured by its geographical position, but is also corroborated by the experience of our mariners. It will also be remembered, that poor Sacheuse, who accompanied Captain Ross, on being interrogated by the Arctic Highlanders who inhabit the regions north of Melville Bay, informed them he came from the south, they disbelieved the assertion, saying there was nothing but ice there. The ice in this bay was unusually abundant during the present season; and it is more than probable, that the southerly wind had prevailed for many months previous, because the ice of last winter's formation was much lighter than usual, in consequence of the atmosphere having been rendered more temperate by the currents of warmer air coming up from the south. If the wind really did prevail from that quarter, it follows that no ice could escape from Baffin's Bay, but would accumulate there, completely covering the sea, which might have been the cause why so many whales were seen in the open sea to the south-westward. We may also mention, in corroboration of this supposition, that when our shipwrecked mariners, having travelled over the ice, reached the shore, they found, in the huts, the unburied bodies of the native families, who had apparently all perished from famine, having, in all probability, been deprived of the opportunity of catching those sea animals on which they live, by the drifting in of the ice on the coast by the continued southerly wind.

The whale-fisher seldom spends less than three, commonly four, tedious months in "*boring*, *warping*, and *sawing*" his way through the entanglements of this icy channel, and if he escapes shipwreck or permanent detention, he arrives at an open sea to the westward, entering on the scene of his whaling operations about the end of July. The whales commonly remain in these regions till August is well advanced, when they take their departure southwards. Adjoining Lancaster Sound, as had been noticed by Baffin himself, the *land-ice* under the sea limits, of which whales take refuge, is commonly still fast to the shore,—there the whaler commences a brisk attack on his prey,—soon completes his cargo,—and in a few weeks, with a merry heart, prepares to return home. The masses of ice which cause so much embarrassment in his outward passage, have now yielded to the benign influence of the season, and the ease of his voyage homewards forms a pleasing contrast with his former toils, and the same navigation which cost him months of anxious labour before, is now effected in a few days.

Now, what does such a view suggest? Our ships sail about the end of February or beginning of March, reach the ice early in April, and generally do nothing till the beginning of August. They are detained all that time by the ice, which every hour threatens them with destruction, and which is reduced to an atom of what it was by the time they are clear of it. Very little of the ice is destroyed during March, April, and

May; it is the warmth of June, and especially of July and August, that melts and breaks it up; so that a vessel entering Davis' Straits early in July, will probably reach Lancaster Sound as soon as if she had followed the present plan, and started three or four months earlier. By such arrangement, the tract through Melville Bay, by this time rendered much less dangerous, might, in most seasons, be altogether avoided; for, at this advanced period of the year, much of the ice having been drifted out into the Atlantic, and the remainder reduced by the warmth of the atmosphere, and spread abroad upon the surface of the sea, may very probably permit a passage across to the west land in a lower latitude *. This arrangement evidently possesses great advantages over that at present pursued. By it the period of the voyage might be shortened one-third, producing the saving of an equal proportion of wages and provisions, and perhaps a reduction of premium of assurance would be the consequence, because the gales, fogs, heavy ice, and long dark nights of spring, would be avoided, much tear and wear would be saved, and the risk of loosing the vessel much diminished.

I am aware that there are arguments in favour of early voyages of no trifling importance; thus, there is a chance of falling in with a few of the scattered fish which may sometimes haunt the south-west fishery ground, and as these are to be met with only in the beginning of spring, an early voyage becomes indispensable. But it must be kept in view, that whales are generally very scarce in that quarter; that they often desert it entirely, and are numerous only on rare occasions, or when the sea to the northward is not open. This station is also disadvantageous, by being exposed to the storms of the Atlantic, with heavy and washed ice, circumstances unfavourable for the

* Such a course was followed by Captain Parry with little opposition, though it must be mentioned, that the Dundee of London three or four years ago, attempting such in a still lower latitude, got endocked in a floe during a gale, where she was frozen fast and detained through the winter; the crew were supplied with provision from the wreck of a Dutchman who, under similar circumstances, had been abandoned. The Dundee was carried by the drifting ice through Davis' Straits, and was not liberated till the spring of the following year.

whale-fishery. It thus rests with those who engage in this business, to judge whether the advantages of an early voyage more than counterbalance the numerous disadvantages attending it. Very few captures of late years have been made on the south-west fishing-ground; so few, indeed, that some of our experienced fishermen consider it a waste of time to visit it. Indeed, on mature deliberation, we doubt not but every one who knows any thing of the business will condemn the present disastrous system. Every year our fleets make hair-breadth escapes,—every year one or two vessels are lost, but such evil being small in proportion to the risk, is actually little thought of. It is only when the calamity becomes general, as has been the case this season,—when ten, a dozen, or a score of vessels are crushed to pieces,—when fifty or a hundred thousand pounds' worth of property is sent to the bottom of the sea,—when we have eight hundred or a thousand families thrown destitute for the winter, some bereft of a father, a brother, or a son,—and when oil rises to fifty or sixty pounds a ton: It is only after such complicated misfortune that we hear of it, and that too with a vengeance.

Having thus given a brief sketch of the prominent peculiarities of this perilous voyage, and adduced ample reasons why the present plan of conducting it should be abandoned, we shall conclude our remarks for the present, by recommending to the enterprising, a method by which the valuable produce of Baffin's Bay may probably be obtained with comparatively little risk.

It is the opinion of experienced fishermen, who have spent half their lives in Greenland, that the sea in the higher latitudes of Baffin's Bay, if it freezes at all, is covered with ice late, and is very early broken up. Adjoining Lancaster Sound, across to the Arctic Highlands, and down along the western shores of the bay, towards the 68° of latitude, they find it always free from ice. In the above opinion, they are supported by the existence of tribes of Esquimaux inhabiting the head of the bay, who are dependent on an open sea for subsistence, who told Sacheuse, that they were the only people in the world, and that the water adjoining their territory, was the only place free from ice, rendered it necessary in their opinion, that Sacheuse and his friends must have come from the moon. Indeed, if we reflect on the direction of the currents in the bay, and that there, as in Spitzbergen sea, northerly gales may prevail during the more inclement months, we may conclude, that, notwithstanding the lowness of the temperature of the water, it should be nearly free from ice *. Now this open space has been found most abundantly frequented by whales, and is perfectly habitable. If so, a number of men suitably equipped might establish themselves on the coast, passing the winter, and during the proper season might secure abundance of blubber, as they were wont in former times, on the shores of Spitzbergen, and so furnish cargoes for vessels visiting the country at a safe season of the year, manned with no more hands than what would be sufficient for their navigation. Independent of the wealth produced by the sea, the land abounds in black, white and red foxes, whose skins are valuable, being covered with a soft fur. No doubt such an establishment could not flourish over a few years, as the whale, wise beast! soon deserts the scene of persecution. Nevertheless, at present it might be a speculation of importance, not only to those who engage in it, but might prove useful also to the miserable natives, who, amidst the most severe privations, have continued so long in this forlorn part of the earth as to have outlived even the tradition of their origin. Acquaintance with Europeans might be the means of contributing to their comforts, and of rendering their residence in the Arctic Highlands more human. But these poor creatures, abandoned to their fate in this corner of the frozen north, if not destined to die out, can never in such a situation be otherwise than low in the scale of civilization.

The whale-fishery has not yet been prosecuted in Hudson's

* "That these north-east gales are sometimes very severe, is demonstrated by a discovery made by Captain Ross, whilst exploring the west side of the entrance to Lancaster Sound,—there we found the skeleton of a whale full 500 yards above high water mark. It had doubtless been thrown dead on the beach, and when the storm blew from the north-east, the train of ice-fields was drifted on the shore, and by the violence of the pressure, the ice-ledge was slid over the land, shoving before it the whale's carcass. We have witnessed similar phenomena on the shores of Spitzbergen."—This we consider to be an important geological fact.—Edit.

Straits, a circumstance rather to be wondered at, as the voyage must necessarily be less hazardous than that to Lancaster Sound, since, according to Captain Parry, Fox Channel at the head of the Straits is not only free from ice during summer, but swarming with whales, unconscious of danger. This is certainly a rich field for future adventure. The entrance to the Straits is for the most part inaccessible till August, being hampered with icebergs driven about by the waves of the ocean; these become less numerous, and more insignificant, with the progress to the westward, until they entirely disappear, when the chief obstruction lies in the floe ice, which had been formed in winter, then in a state of rapid solution.

LEITH, *Nov.* 30. 1830.

Observations on the History and Progress of Comparative Anatomy. By DAVID CRAIGIE, M.D. &c. Communicated by the Author *.

FEW sciences have undergone greater vicissitudes in their progressive advancement, than that of comparative or animal anatomy. Originating at an earlier period than that of the human frame, and cultivated as a substitute for it, both by the ancients and also by some of the moderns, it fell under the contempt and degradation which all misapplied departments of knowledge are destined to incur. When at length prejudice began to subside, and reflection taught anatomists that the knowledge of the structure of the lower animals, if kept in its proper place, and made subsidiary to, but not substituted for, that of the human body, may be not only free from harm, but productive of the greatest benefits, it began to attract the attention of physiologists, and to assume something like a definite rank among the natural sciences.

It may be observed, nevertheless, that on this subject a considerable degree of misconception prevails, both generally, and also amongst those whose pursuits require some knowledge of

* Dr Craigie is author of Elements of General and Pathological Anatomy, 1827; joint Editor of the Edinburgh Medical and Surgical Journal, and conductor of the Anatomical department of the Encyclopædia Britannica.—EDIT.

the structure of the human frame. Whatever be the cause, it requires little penetration to perceive, that, with the exception of those eminent and intelligent persons who have devoted their lives almost to the cultivation of this branch of natural knowledge, very indistinct and inaccurate notions of the nature and objects of comparative anatomy are entertained. Regarded as an appendage to human anatomy, or as the occasional source of comparative illustrations, animal anatomy has been appealed to chiefly when it promised to explain obscure and anomalous points in the structure of the human body; and its cultivation has consequently been too exclusively confined to those who were known as mere human anatomists.

That this is a sufficiently legitimate application of the lights of comparative anatomy, I do not deny. But while it is defective in giving a very limited view of the nature and objects of the science, it has had the bad effect of giving currency to the opinion, that comparative anatomy is merely a subordinate department of human knowledge, occupying only an inferior rank in the scale of natural science. The very name also by which it has been distinguished, has contributed in no ordinary degree to convey an erroneous impression of its objects. Though one of the principal objects of all human inquiry is, in one sense, *comparison* of different objects, and the formation of general conclusions from these comparisons; yet, so long as the structure of animal bodies is studied merely in reference to the standard or type, furnished by the organs of the human frame, it may be safely asserted, that it can derive neither advantage nor illustration from the general principles of philosophical research. Animal anatomy, or zootomy, as it may be more justly denominated, instead of being regarded as a subordinate appendage of human anatomy, is itself a comprehensive science, embracing the knowledge of all the varieties of structure exhibited by the classes, orders, and tribes of the animal world, and of which that also of the human subject forms only a constituent part. The latter, indeed, has justly acquired pre-eminent interest, from its connexion with the art of preserving life and healing disease. But these circumstances cannot give it, as a branch of science, a rank higher than that of the organic constitution of animal bodies generally, or erect the structure of the human frame into a general standard of reference; and while the importance of correct knowledge of the latter is readily admitted, that of the animal tribes generally is not less valuable, in reference to the great purpose of illustrating the nature and characters of animal structure and living actions.

The soundness of these principles it would be easy to illustrate and enforce, in different modes. But perhaps by no method can they be placed in so clear a point of view as by the history of the science itself, and of the successive stages through which it has passed. In this manner we shall be enabled to appreciate the estimation in which it has at different periods been held, to understand the objects with which it has been cultivated, to distinguish the impediments by which its progress has at different periods been obstructed, and to form a just idea of its utility and applications when cultivated, without reference to temporary, local, or particular purposes, and on the general principles of philosophical inquiry.

Sect. I.—*Aristotle and Ancients.*

The first person who can be said to have cultivated comparative anatomy systematically, and in a scientific manner, is Aristotle; and it is an interesting circumstance in the history of science, that the same individual who distinguished himself by the depth and accuracy of his views on the political constitution of society, and the acuteness of his analytical powers in investigating the history of the human mind, and applying it to morals and literature, was also the first to explain the structure of animal bodies. It is further important to remark, that it was to the peculiar construction of his mental faculties, and his turn for generalization, that the success and the failures of the philosopher of Stagira may be traced in both these opposite departments of science; and while most of his political and metaphysical opinions are erroneous, in being founded on too limited a series of observations, the results of his zootomical researches, in which he was less likely to be misled by mere speculation, constitute a collection of facts, of which the value has been recognised by the most distinguished modern anatomists. Aristotle is almost a solitary example of an individual, who, finding the natural sciences in general, and zoology and zootomy in particular, quite in their infancy, collected by personal observation a great number of facts, classified them in systematic order, and derived from them useful general conclusions; and while to these efforts comparative anatomy may be said to have owed its existence entirely, he further rendered the substantial service of being the first to apply its facts to the elucidation and distinctions of zoology. Generalization, indeed, distinction and classification, were the predominant features of the mind of the Stagirite; and while to these objects all his individual observations were directed, they appear to have afforded the principal incentive to diligence in observing and collecting. The works of this ardent naturalist shew that his zootomical knowledge was extensive and often accurate; and from several of his descriptions, it is impossible to doubt that his information was derived from personal dissection.

Aristotle, who was born at Stagira, in the first year of the 99th Olympiad, or 384 years before the Christian era, was, at the age of 39, requested by Philip of Macedon to undertake the education of his son Alexander; and during this period he is believed to have composed several works on anatomy which are now lost. The military expedition of his royal pupil into Asia, by laying open the forests and wilds of that vast and little known continent, furnished Aristotle with the means of extending his knowledge of the history and structure of the animal tribes, and of communicating to the world more accurate and distinct notions than were yet accessible. A sum of 800 talents, and the concurrent aid of numerous intelligent assistants in Greece and Asia, were intended to facilitate his researches in composing a system of zoological knowledge; but it has been observed, that the number of instances in which he was thus compelled to trust to the testimony of others, led him to commit errors in description, which personal observation might have enabled him to avoid.

The three first books of the *History of Animals* (Περι Ζωων Ἱστοριας), a treatise consisting of ten books, and the four books on the *Parts of Animals* (Περι Ζωων Μοριων), constitute the principal memorials of the *Aristotelian Anatomy*. From these we find, that Aristotle had already recognised the distinctions of animals into viviparous (ζωοτοκα), oviparous (ωοτοκα), and vermiparous (σκωληκοτοκα). Of the viviparous, he adduces as examples, man, the horse, the sea-cow (φωκη), and those covered by hair; and among marine animals, the cetaceous, as the dolphin and the cartilaginous fishes (σελαχη), and of these he afterwards states that some are oviparous.

In some interesting observations in the beginning of the second book, on the common characters of animals, and on those proper to certain tribes and genera, he distinguishes accurately the five toes of the elephant; the great strength, mobility, and flexibility of the trunk; the peculiar power of stooping on the hind legs; and the small quantity of shag on his hide. He distinguishes also the Bactrian from the Arabian camel, by the two protuberances, and mentions the single-hoofed hogs of Illyria and Paeonia, a peculiarity which was afterwards observed by Linnæus in those of Sweden. The lower extremities of the human subject, he observes, are distinguished by the disposition of the muscles, which render the hips, thighs and legs much more fleshy in comparison than in quadrupeds; and in man alone, he remarks, is the foot muscular. In speaking of the teeth, he observed, that horned animals are void of incisors in the upper jaw, a character connected with the manner of life and the kind of food. He corrected the erroneous statements of Polybus, Syennesis, and Diogenes, regarding the bloodvessels, which they asserted to proceed from the head and brain, and of others who contended they issued from the liver, but which he demonstrated arose from the heart. His description of this organ contains a singular mixture of truth and error. While he accurately distinguishes the site and position of the human heart from that of quadrupeds, as inclined obliquely to the left side of the chest, he represents it to contain three chambers (εχει μεν τρεις κοιλιας), a large one on the right connected with the large vein (ἡ μεγαλη φλεβς), the *vena cava*, a small one on the left, and one of middle size in the middle, connected with the aorta; while he states also, that these chambers are pervious towards the lung, by specifying canals (ὁι απο της καρδιας πορoι) proceeding from the heart to the lung, which accompany the ramifications of the wind-pipe (αρτηρια), he shews that he knew the pulmonary artery, and perhaps the pulmonary veins. It is further remarkable, that though he repeatedly represents the heart as the origin of the bloodvessels, as full of blood, and the source of that fluid, and even speaks of the blood flowing from it to the veins, and to all parts of the body, he says nothing of the circular motion of the blood.

The bloodvessels he represents to be two in number, placed before the vertebral column, the large on the right (φλεβς μεγαλη) *the vena cava*, the small on the left, named *aorta* (αορτη), the first time, I may observe, that this epithet occurs,—both proceeding from the chambers of the heart. He distinguishes the thick, firm and tendinous texture of the aorta, which he represents to be a nervous or tendinous vein (νευρωδης φλεβς), from the thin membranous tissue of the vein. In describing the distribution of the latter, however, he confounds the *vena cava* and pulmonary artery; and, as might be expected, he confounds the ramifications of the former with those of the arterial tubes in general; and, in short, applies the term *veins* (φλεβες) to the distributing tubes proceeding from the heart. The course and distribution of the aorta, which he regards as a small bloodtube, he describes with some accuracy. Though he omits the cœliac, and remarks that no vessel proceeds directly from the aorta to the liver or spleen, he had observed the mesenteric, the renal, two tubes proceeding towards the bladder, evidently the spermatics, and the common iliac arteries.

The brain he describes as an organ sparingly supplied with blood, but of greater proportional size in man than in any other animal, and larger also in males than in females, a remark which is either a very fortunate conjecture, or the result of much observation *. In opposition to the majority of ancient anatomists, he denied the brain to consist of marrow, because, while the former is cold, the latter is hot, as appears from its adipose and unctuous characters. The spinal chord, however, he allows to be medullary. On the nerves his ideas are indistinct and confused. Making them rise from the heart in the large chamber of which there are nerves (νευρα) *tendons*, he confounds them with the branches of the aorta, which he denominates a tendinous vein (νευρωδης φλεβς). By afterwards saying, that all the articulated bones are connected by nerves, he makes them the same as ligaments, while the property

* Ἐχει δε των ζωων ἐγκεφαλον πλειστον ἀνθρωπος, ὡς κατα μεγεθος, και των ανθρωπων οἱ ἀῤῥενες των θηλειων. Περι Ζωων Μοριων. Lib. ii. cap. vii.

of divisibility in the long direction identifies them with tendons; and the assertion, that no part destitute of nerves has sensation, makes them equivalent to the nervous chords of the modern anatomist. The opinion of Sprengel, that he was the first to recognise this remarkable property in these chords I would willingly adopt, were I not satisfied that he had not formed any definite idea on these functions.

He distinguishes the air-holder or windpipe (αρτηρια) as the tube for conveying air to the lungs, and the organ of voice, remarks its position anterior to the œsophagus, and refutes the error of those who assert that it receives drink, which causes cough and suffocation, and because he observes there is no passage from the lung to the stomach, as there is by the œsophagus. To obviate this inconvenience, he remarks, nature has placed in its upper extremity a small lingual appendage (εως γνσσις), the epiglottis, and not in all viviparous animals, but only in those which breathe by lungs. His account of the latter is more physiological than anatomical; and the treatise *on Respiration*, in which more is said, appears to be the factitious product of a later age.

The limitrophic, or alimentary organs, are the parts with which Aristotle appears to be most familiar. The diaphragm or midriff he distinguishes by the names διαζωμα and ὑποζωμα, as the great partition between the heart and lungs or noble organs, from the abdominal viscera (τα σπλαγχνα) or ignoble. With the position of the liver and spleen, and the whole alimentary canal, he shews intimate acquaintance. He recognizes the peculiarities of the stomach in different tribes of animals, and distinguishes by name the several parts of the quadruple stomach of the ruminating animals in the following order: κοιλια, *penula*, *ingluvies*, the paunch; κεκρυφαλος, *reticulum*, the kingshood; ἐχινος, *omasum*, the manyplies; και ἠνυστρον, *abomasum*, the red. He distinguishes between the membranous stomachs of the carnivorous animals and birds, and the muscular ones of the granivorous. He remarks the numerous appendages or *cæca* connected with the *duodenum* of fishes, and he even traces the relation between the teeth and the several forms of stomach; and the length or brevity, the simplicity or complexity, and the direct or circuitous course of the intestinal tube, and the kind of food used by the animal. On the same principle he distinguishes the *jejunum* (ἡ νηστις), or the empty portion of the small intestines, το εντερον λεπτον; the *cæcum* (τυφλον τι και ογκωδες); the colon (το κωλον); and the sigmoid flexure (στενωτερον τε και ειλιγμενον). The modern epithet of *rectum*, is the literal translation of his description of the straight progress (ευθυ) of that bowel to the anus (πρωκτος). The mesentery he describes as a membrane full of bloodvessels, continued from the attachment of the intestinal canal.

Aristotle had dissected the elephant, and the general accuracy of his description is verified by Camper. The intestine of this animal the Stagirite represents as consisting of united portions or cells (εντερον συμφυσεις εχον, ωστε φαινεσθαι τετταρας κοιλιας εχειν), so as to exhibit the aspect of the quadruple stomach; but he takes care to remark, that in this cavity the food was deposited, and that there was no other receptacle. He also remarks the similarity of the intestinal canal of the elephant to that of the hog, thus anticipating the arrangements of the best modern zoologists.

Fishes he had distinguished by the peculiarity of having gills (βραγχιας), and scaly or rough bodies. Of the gills, he remarks, some have covers, others are uncovered, to the latter of which all the cartilaginous fishes (σελαχη) belong. He remarks their serrated teeth (καρχαροδοντες), disposed in manifold rows, (πολυστοιχους), and the hard thorny tongue; and he further distinguishes them into oviparous and viviparous. In these distinctions, Aristotle has displayed more philosophical precision than even Linnæus.

No subject perhaps has Aristotle studied more attentively in the different classes and orders of the animal world, than that of reproduction; and in general his observations are accurate, and he labours to refute the vulgar errors then current on this obscure topic. His researches on this subject, however, are rather physiological than anatomical; and the mistakes into which he has fallen, may always be traced to imperfect knowledge of the functions.

Aristotle was followed by Diocles of Carystus, and Praxagoras of Cos, the last of the family of the Asclepiadæ. To the latter belongs the merit of rectifying one of the great errors of the Stagirite, by distinguishing the arteries from the veins. By teaching that the former were air-vessels, however, he contributed to perpetuate an error, which has had more influence than any other, in retarding the progress of accurate anatomical knowledge. From this circumstance, it is not unlikely that the book on Respiration, ascribed to Aristotle, is the production either of Praxagoras or of some of his disciples. It is further a singular circumstance, that Praxagoras is the first who regarded the brain as an efflorescence or expansion of the spinal chord, an opinion which might have been suffered to rest in undisturbed tranquillity, had it not been made the basis of a very elaborate theory by MM. Gall and Spurzheim.

Erasistratus, a pupil of Chrisippus and Aristotle, distinguished himself by dissecting, not only the bodies of the lower animals but that of the human race. He recognised the lacteals in the mesentery of the kid; he described the semilunar valves at the beginning of the aorta, and the tricuspid or triglochin (τριγλωχινες) at the base of the right ventricle; he demonstrated the brain, and compared that of man with those of the lower animals; he shewed the nerves proceed from the brain; and he distinguished them into two classes, those of sensation and those of motion.

Herophilus, the pupil of Praxagoras, and contemporary of Erasistratus, has been distinguished among the ancients as the great cultivator of the anatomy of the human body. Of these he probably dissected more than any of his predecessors or contemporaries. But the exaggerated statement of Tertullian has been absurdly repeated by almost every author, to prove that he dissected 600 corpses *. The classical reader is aware that the term 600 is invariably used by the Roman authors in a general hyperbolical sense to signify many, but by no means an exact number, and may as likely signify 16 as 600. With his dissection of the human body, however, we have at present

* Herophilus ille, medicus aut lanius, qui sexcentos exsecuit ut naturam scrutaretur, qui hominem odit ut nosset, nescio an omnia interna ejus liquido explorarit, ipsa morte mutante quæ vixerant, et morte non simplici, sed ipsa inter artificia exsectionis errante. Tertullian de Animâ, c. 10. p. 757. Balnea *sementis*, de plùris portuus, in qua Gestetur dominus quoties pluit. Juven. Sat. vii. 178.

little concern. As a cultivator of animal anatomy, he appears to have understood perfectly the configuration of the brain; he described the posterior end of the vault or *fornix* as the principal seat of the sensations; he knew the cerebellic or fourth ventricle; and we learn from Galen, that he was the first who applied to the linea furrow, at its inferior region, the name of *calamus scriptorius*, or writing pen. He described well the choroid or vascular membrane, and he distinguished the fourth or straight sinus which still bears his name, (ληνος) *torcular Herophili.* Though, in imitation of Aristotle, he denominates the nerves πωροι (*pori*) or tubes, he maintains that all of them proceed from the brain, and he distinguishes them into those of sensation and those of motion. He first applied the name of 12 inch bowel or *duodenum* (δωδεκα δακτυολς) to that part of the alimentary canal (εκφυσις) which is next the stomach. He gives a good description of the liver, which Galen has thought deserving of preservation; and an important discovery is the distinction which he establishes between the mesenteric vessels which proceed to the liver and *vena portæ*, and those which, going to the mesenteric glands, were manifestly the lacteals. Of these, however, he appears to have formed less distinct notions than Erasistratus. To Galen also we are indebted for a description of the organs of the hare by Herophilus. By giving the pulmonary artery the denomination of arterious vein, it may be inferred that he had distinguished the kind of blood which that vessel conveys; but though he studied attentively the beats of the arteries in the living body, he appears to have framed no distinct conception of the circular motion of the blood. The organs of generation he appears to have studied attentively in both sexes. He has anticipated the moderns, in finding the epididymis to be a cluster of vessels, and he had seen the *vas deferens*, at least in the dog, and probably the *vesiculæ seminales* and prostate gland. He appears also to have seen the ovaries in the female.

These two distinguished anatomists had given to the school of Alexandria a degree of celebrity, which appears to have been fatal to their successors. For neither among them, nor among any of the subsequent philosophical authors, do we find any name entitled to mention in the history of animal anatomy. Cicero, indeed, in his treatise *de Natura Deorum*, gives some anatomical sketches from the *Timæus* of Plato, and labours to shew the proofs of design in the construction of the animal machine. Little, however, can be expected from an author who evidently labours under the prejudice common to the Romans, of regarding dissection as a degrading and contaminating occupation, and who informs his readers, that, from motives of delicacy, he omits the description of the alimentary canal. From this censure I am happy to except the elegant and philosophical Celsus, who has left an accurate description of the relative position of the windpipe and lungs, and the heart, the windpipe and œsophagus (*stomachus*), which leads to the stomach (*ventriculus*), the intestinal canal in general, the diaphragm, liver, spleen and kidneys. In osteology his information is minute, and in general accurate.

The Romans, however, were never distinguished for the cultivation of science; and if their literature cannot justly be said to be of indigenous growth, the few scientific treatises which they possessed, were either the production of some Grecian scholar, or copied from the works of some of the Greek authors. The Greek language, which was not confined to Greece, but spoken over the whole of Asia Minor, was diffused after the conquests of Alexandria over Egypt and much of the south of Africa; and even by the successive extension of the Roman dominion, the general prevalence of the language, literature, and science of the Greeks was promoted. In this manner, many learned Greeks, and others speaking the Greek language, or what are denominated Hellenizing foreigners, found their way to Rome, the great centre of enterprize, and the only place where their learning was likely to be employed or appreciated. It is a curious fact, indeed, that most of those who were distinguished among the Romans for the cultivation of literature, and especially science, after the Augustan age, were either native Greeks or foreigners who wrote in the Greek language; and, among other sciences, medicine and anatomy had its full share of these votaries. With the single exception of Pliny, to whom, as a servile copyist of Aristotle, I can scarcely assign a place in this sketch, all those whose names are recorded as naturalists, physicians, or anatomists, belong to the class now defined. Such were Aretæus the Cappadocian, Agathinus, Soranus of Ephesus, Moschion, Archigenes, Dioscorides, Marinus, Ruffus of Ephesus, Galen, and Oribasius.

Of these, Aretæus is commemorated for describing with some accuracy the vena cava, the round and broad ligaments of the womb, the pelvis of the kidney, and the proper muscle of the tongue; and for teaching the glandular nature of the liver, kidneys, and female breast. Soranus of Ephesus, who must be distinguished from the physician of the same name, made some accurate observations on the bladder, testicles, and womb. Ruffus recognised the ramifications of the olfactory nerves in the ethmoid bone, and the lower termination of the middle cerebral ventricle named the *infundibulum.* He shewed that the eminences in the liver of the lower animals observed by the *Haruspices*, are indistinct in that of man, and he knew the biliary duct. He describes the *testes* as pulpy bodies, two seminal glands, apparently the prostate, and two varicose bodies, apparently the seminal vesicles. The Fallopian or uterine tubes he describes from the sheep; and from his account of the allantois or urinary membrane, and speaking of two umbilical veins, it is manifest that he had dissected chiefly, if not entirely, the lower animals. He describes also the genital organs of the she-goat. Ruffus farther distinguishes the nerves into those of sensation and those of motion. He knew the recurrent nerve. He made experiments on living animals, and his name is associated with that of compressing, in the situation of the carotid arteries, the pneumogastric nerve, and thereby inducing insensibility and loss of voice.

Of all the authors of antiquity, however, none possesses so just a claim to the title of anatomist, as Claudius Galenus, the celebrated physician of Pergamus. For the particulars of his life and education, I refer to his biographers. It is sufficient to say, that he was born about the 131st year of the Christian era, and lived under the reigns of Trajan, Antonine, Commodus, and Aelius; and that he was trained by his father Nicon, whose memory he embalms as an eminent mathematician, architect, and astronomer, to all the learning of the day, and initiated particularly in the mysteries of the Aristotelian philosophy. After devoting his attention to various medical studies under different teachers, in different cities, for several years, and studying anatomy particularly at Alexandria, under Heraclianus, till his 28th year, he appears to have regarded himself as possessed of all the knowledge then attainable through the medium of teachers. A seditious tumult at Pergamus where he had settled, made him form the resolution of quitting that place and proceeding to Rome, where he remained five years, and after visiting his native place, and travelling some time, he finally fixed his residence in the imperial city, as physician to the Emperor Commodus.

The anatomical writings ascribed to Galen, which are numerous, are to be viewed, not merely as the result of personal research and information, but as the common depository of the anatomical knowledge of the day, and as combining all that he had learnt from the several teachers under whom he successively studied, with whatever personal study had enabled him to acquire. It is on this account not always easy to distinguish what Galen had himself ascertained by personal research, from that which was known by other anatomists. This, however, though of moment to the history of Galen as an anatomist, is of little consequence to the science itself; and, from the anatomical remains of this author, a pretty just idea may be formed, both of the progress and of the actual state of the science at that time.

Though various anatomical writings are ascribed to Galen, those entitled *Anatomical Administrations,* in nine books, must be regarded as the best. His treatise on the *Uses of the Parts*, though much more frequently mentioned, and apparently better known, is more physiological; and the anatomical descriptions are much corrupted by speculations on final causes, and ultimate purposes. Though his osteology is derived from the human skeletons, which he informs us were preserved at Alexandria, it is evident that in general his descriptions of the soft parts were derived from the bodies of the lower animals; and of their structure his knowledge was extensive and accurate.

The osteology of Galen is the most perfect of the departments of the anatomy of the ancients. He names and distinguishes the bones and sutures of the cranium nearly in the same manner as at present. Thus he notices the quadrilateral shape of the parietal bones: he distinguishes the squamous, the styloid, and the mastoid portions, and the lithoid or petrous portions of the temporal bones; and he remarks the peculiar situation and shape of the wedge-like or sphenoid bone. Of the ethmoid, which he omits at first, he afterwards speaks more at large in another treatise. The malar he notices under the name of zygomatic bone; and he describes at length the upper maxillary and nasal bones, and the connection of the former with the sphenoid. He gives the first clear account of the number and situation of the vertebræ, which he divides into *cervical*, *dorsal*, and *lumbar*, and distinguishes from the *sacrum* and *coccyx*. Under the head *Bones of the Thorax*, he enumerates the sternum, the ribs (αἱ πλευραὶ), and the dorsal vertebræ, the connection of which with the former he designates as a variety of *diarthrosis*. The description of the bones of the extremities and their articulations concludes the treatise.

Though in myology Galen appears to less advantage than in osteology, he nevertheless had carried this part of anatomical knowledge to greater perfection than any of his predecessors. He describes a frontal muscle, the six muscles of the eye, and a seventh proper to animals; a muscle to each *ala nasi*, four muscles of the lips, the thin cutaneous muscle of the neck, which he first termed *platysma myoides*, or muscular expansion, two muscles of the eyelids, and four pairs of muscles of the lower jaw, the temporal to raise, the masseter to draw to one side, and two depressors, corresponding to the digastric and internal pterygoid muscles. After speaking of the muscles which move the head and the *scapula*, he adverts to those by which the windpipe is opened and shut, and the intrinsic or proper muscles of the larynx and hyoid bone. Then follow those of the tongue, pharynx, and neck, those of the upper extremities, the trunk, and the lower extremities successively; and in the course of this description he swerves so little from the actual facts, that most of the names by which he distinguishes the principal muscles have been retained by the best modern anatomists. It is chiefly in the minute account of these organs, and especially in reference to the minuter muscles, that he appears inferior to the moderns.

The angiological knowledge of Galen, though vitiated by the erroneous physiology of the times, and ignorance of the separate uses of the arteries and veins, exhibits, nevertheless, some accurate facts which shew the diligence of the author in dissection. Though, in opposition to the opinions of Praxagoras and Erasistratus, he proved that the arteries in the living animal contain not air, but blood, it does not appear to have occurred to him to determine in what direction the blood flows, or whether it was movable or stationary *. Representing the left ventricle of the heart as the common origin of all the arteries, though he is misled by the pulmonary artery, he nevertheless traces the distribution of the branches of the aorta with some accuracy. The *vena azygos*, also, and the jugular veins, have contributed to add to the confusion of his description, and to render his angiology the most imperfect of his works.

In neurology, we find him to be the author of the dogma, that the brain is the origin of the nerves of sensation, and the spinal chord of those of motion; and he distinguishes the former from the latter by their greater softness or less consistence. Though he admits only seven cerebral pairs, he has the merit of distinguishing and tracing the distribution of the greater part of both classes of nerves with great accuracy.

His description of the brain, though derived from dissection of the lower animals, is accurate; and his distinctions of the several parts of the organ have been retained by modern anatomists. His mode of demonstrating this organ, which indeed is clearly described, consists of five different steps. In the first, the bisecting membrane, *i. e.* the falx (μηνιγξ διχοτομουσα), and the connecting bloodvessels are removed; and the dissector, commencing at the anterior extremity of the great fissure, separates the hemispheres gently as far as the *torcular*, and exposes a smooth surface (την χωραν τυλωδη πως ουσαν), the mesolobe of the moderns, or the middle band. In the second, he exposes, by successive sections, the ventricles, the choroid plexus, and the middle partition. The third exhibits the conoid body (σωμα κωνοειδες) or conarium, or pineal gland of the modern anatomists, concealed by a membrane with numerous veins, meaning that part of the plexus which is now known by the name of *velum interpositum*, and a complete view of the

* Περι Ανατομικων Εγχειρησεων, lib. vii.

ventricles. The fourth unfolds the third ventricle (τις αλλη τριτη κοιλια), the communication between the two latter ones, the psalloid or arch-like body (σωμα ψαλιδοειδες), *fornix*, and the passage from the third to the fourth ventricle. In the fifth, he gives an accurate description of the relations of the third and fourth ventricle, of the situation of the two pairs of eminences, *nates*, (γλουτα) and *testes* (διδυμια vel ορχεις), the scolecoid or worm-like process, anterior and posterior, the tendons or processes, and, lastly, the linear furrow, called by Herophilus *calamus scriptorius* *. He appears not to have known the inferior recesses. Morgagni however concludes, from a passage of the 7th book περι Δογματων, that he did; but after accurately examining this and others of his anatomical writings, I cannot see any good reason for admitting the inference.

In the account of the thoracic organs, equal accuracy may be recognised. He distinguishes the *pleura* by the name of inclosing membrane (ὑμην ὑπεζωκως, *membrana succingens*), and remarks its similitude in structure to that of the peritoneum, and the covering which it affords to all the organs †. The pericardium, also, he describes as a membranous sac with a circular basis corresponding to the base of the heart, and a conical apex; and after an account of the tunics of the arteries and veins, he speaks shortly of the lung, and more at length of the heart, which, however, he takes some pains to prove not to be muscular, because it is harder, its fibres are differently arranged, and its action is incessant, whereas that of muscle alternates with the state of rest. In the particular description of the parts of the organ he ascribes to the auricles a more cuticular structure than to the other parts; he gives a good account of the valves and of the vessels; and notices especially the bony ring formed in the heart of the horse, elephant, and other large animals.

The description of the abdominal organs, and of the kidneys and urinary apparatus, is still more minute, and in general very accurate. Our limits, however, do not permit us to give any abstract of them; and it is sufficient in general to say, that Ga-

* Περι Ανατομικων Εγχειρησεων, lib. ix.

† Αλλ' ὁ ὑπεζωκος οὑτως ὑποτεινεται πασι τοις ενδον του θωρακος οργανοις ὡς ὁ περιτοναιος ελεχθη, και εδειχθη τοις κατω των φρενων. *Ibid.*

len gives correct views of the structure and distribution of the peritoneum and omentum, and distinguishes accurately the several divisions of the alimentary canal, and the internal structure of its component tissues. In the liver, which he allows to receive an envelope from the peritoneum, he admits, in imitation of Erasistratus, a proper substance or *parenchyma*, interposed between the vessels, and capable of removal by suitable dissection.

His description of the organs of generation is rather brief, and is, like most of his anatomical sketches, too much blended with physiological dogmas.

This short sketch may communicate some idea of the condition of anatomical knowledge in the days of Galen, who indeed is justly entitled to the character of rectifying and digesting, if not of creating, the science of anatomy among the ancients. Though evidently confined, perhaps entirely, by the circumstances of the times, to the dissection of brute animals, so indefatigable and judicious was he in the mode of acquiring knowledge, that many of his names and distinctions are still retained with advantage in the writings of the moderns. Galen was a practical anatomist, and not only describes the organs of the animal body from actual dissection, but gives ample instructions for the proper mode of exposition. His language is in general clear, his style as correct as in most of the authors of the same period, and his manner is animated. He appears to have been the first anatomist who can be said, on authentic grounds, to have attempted to discover the uses of organs by vivisection and experiments on living animals. In this manner, he determined the position, and demonstrated the action, of the heart; and he mentions two instances in which, in consequence of disease or injury, he had an opportunity of observing the motions of this organ in the human body. In short, without eulogizing an ancient author at the expense of critical justice, or commending his anatomical descriptions as superior to those of the moderns, it must be admitted that the anatomical writings of the physician of Pergamus form a remarkable era in the history of the science; and that, by diligence in dissection, and accuracy in description, he gave it a degree of stability and precision which it has retained through the lapse of many centuries.

(To be continued.)

On the occurrence of Chalk-flints in Banffshire. By James Christie, Esq. Secretary to the Banff Institution. Communicated by the Author *.

Some time ago I took the liberty of submitting for your inspection specimens of a quantity of flints found scattered and mixed with the water-worn stones and shingle along the shore of Boyndie Bay †, to the westward of Banff, and to state, that flints of a similar description are occasionally found to the eastward as far as Peterhead. I had not seen any organic remains in the flints of this part of Scotland, to enable me to form an opinion as to their being of the chalk-formation ‡. Since that time, I have met with abundance of flints on the hill or rising ground between Turiff and Delgaty Castle. The surface of the ground there is irregular, rising occasionally into hillocks, and sinking into hollows, filled with bogs and swamps. These hillocks are composed of a conglomerate or pebbly mass, having a base or ground of white or grey colour, and apparently composed of decayed felspar, and very minute scales of mica or talc, or both, in which are imbedded rounded pebbles of greyish-white translucent quartz-rock. The quartz-pebbles are from the size of a pea to that of a hen's egg. This conglomerated mass is here and there alternated with or traversed by a white quartzy sand, with scales of mica. The whole conglomerated mass is mixed up with *flints*, of various sizes and forms. The flints are yellow,

* At p. 381. of last volume of this Journal, we noticed Mr Christie's discovery of flints on the shore near Banff.—Edit.

† The flints sent me from Boyndie Bay, are of the same description with those found near Delgaty. They contain traces of zoophytic organic remains.—Edit.

‡ Some years ago, while examining the geognosy of the vicinity of Peterhead, our attention was directed to the chalk-flints found in that neighbourhood, by previous information. We traced them extending over several miles of country, and frequently imbedded in a reddish clay, resting on the granite of the district. These flints contain sponges, alcyonia, echini, and other fossils of the chalk-flint, thus proving them to belong to the chalk formation, which itself will probably be found in some of the hollows in this part of Scotland.—Edit.

brown, and grey, more or less translucent, often enveloped in a white siliceous opaque crust, and containing organic remains principally of sponges or alcyonia. In some flints the centre is hollow, and the walls of the cavity lined with calcedony. One of the hillocks has been opened to the depth of about fifteen or eighteen feet. The quartz-pebbles become more translucent the deeper the pit is opened; and the flints, which, at the surface of the ground, are generally of a brown colour, exhibit other tints in the interior of the bed. The hollows between the hillocks are destitute of pebbles and gravel, and have a clayey bottom. The direction of the hollows appears in general to run east and west. These hollows may perhaps have been scooped out, and the beds containing flints and pebbles of quartz carried off by some of those mighty inundations which have more than once swept over the face of nature.

As to the extent of the deposite, I can say but little: in one direction, I have traced it for nearly a mile, occasionally interrupted by the hollows. The point where the specimens were taken up, is about half a mile distant from another patch, through which the ditch I formerly mentioned has been cast. At that point, also, the flints and quartz-pebbles, and other deposites, are the same as those already mentioned. The spot where these deposites are found is in the interior of the country, about ten miles from the sea, and is the highest ground in the neighbourhood. I have not been able to ascertain the depth of the bed, as the pit filled with water on digging down, and the water became thick with the clayey or chalky matter. The workmen, however, told me, that farther down the hill they had met with a bed of white clay, and they believed the deposite of pebbles, flints, &c. rested on it.

I have never seen the chalk formation, but, as I understand it, this deposite has many features of its upper strata. The flints are abundant throughout the whole, and I found them on the surface at a mile distant from the hillock where the specimens were taken from *.

* We trust Mr Christie, and other members of the Banff Institution, will continue their researches in regard to these flints, for possibly the chalk-formation itself may be found *in situ* in this part of Scotland.—Edit.

Aërial Shadows seen from the Cairngorm Mountains. By JOHN MACPHERSON GRANT, Esq. jun. of Ballindalloch. In a Letter to the Editor.

As you expressed a wish to have some account, in writing, of the atmospheric appearance seen by Sir Thomas Dick Lauder, and myself, in our late ramble among the Cairngorms, I have transcribed the following passage from my note-book, and attempted to give, by the accompanying diagram, some idea of the beautiful phenomenon which we witnessed *.

" On the 10th October 1830, at 3 P. M. we reached the summit of Ben-mac-dhuie. A thick mist enveloped the mountain, like a curtain, concealing from view the whole of the surrounding range of the Cairngorms, with the exception of the giant hill on which we stood, and the scarce less elevated tops of Cairentoul and Bræriach. The upper bounding line of the mist was so perfectly horizontal, and the apparent undulations on its surface resembled so closely the waves of the sea, that it was extremely difficult to divest one's-self of the idea that we stood on some desert rock in a vast ocean, with two others of similar character in sight. The day was fine; and the sun, though fast declining to the west, shone so bright and powerfully on the huge masses of granite around us, that we sat down for more than half an hour to rest from our fatigues, and to prolong, as far as might be, the satisfaction of being on the highest ground in Britain.

" On descending from the top, at about half past three P. M., an interesting optical appearance presented itself to our view. We had turned towards the east, and the sun shone on our backs, when we saw a very bright rainbow described on the mist before us. The bow, of beautifully distinct prismatic colours, formed about two-thirds of a circle, the extremities of which appeared to rest on the lower portion of the mountain. In the centre of this incomplete circle, there was described a luminous disc, surrounded by the prismatic colours displayed in concentric rings. On the disc itself, each of the party (three in number), as they stood at about fifty yards apart, saw his own figure most distinctly delineated, although those of the other two

* The diagram will be given in next Number of Journal, having been received too late for the present.

were invisible to him. The representation appeared of the natural size, and the outline of the whole person of the spectator was most correctly pourtrayed. To prove that the shadow seen by each individual was that of himself, we resorted to various gestures, such as waving our hats, flapping our plaids, &c. all which motions were exactly followed by the airy figure. We then collected together, and stood as close to one another as possible, when each could see three shadows on the disc; his own, as distinctly as before, while those of his two companions were but faintly discernible.

"As the autumnal day was fast declining, and we had a long walk before us to Braemar, we were forced to hurry down the rugged sides of Loch Etichan; and, being consequently soon enveloped in the mist, we lost sight of the atmospheric phenomenon, but not until it had been distinctly visible to us for about a quarter of an hour."

Edinburgh, 4*th Dec.* 1830.

Description of several New or Rare Plants which have lately flowered in the neighbourhood of Edinburgh, and chiefly in the Royal Botanic Garden. By Dr Graham, Professor of Botany in the University of Edinburgh.

10*th Dec.* 1830.

Banksia speciosa.

B. *speciosa;* foliis linearibus, pinnatifidis, lobis triangulari-semiovatis mucronatis, subtus niveis, obsolete nervosis; calycis laminis lanatis; stylo pubescente; folliculis tomentosis.—*Brown.*

Banksia speciosa, *Br.* Trans. Linn. Soc. 10. 210.

Description.—*Trunk* erect, branched; branches spreading, towards their extremities densely covered with snowy tomentum. *Leaves* (1½ foot long, 1½ inches broad) scattered, linear, attenuated at the base, and very slightly at the apex, truncated, pinnatifid, nerved and reticulated, covered on both sides, when young, with short dense white tomentum, which is beautifully snowy below, when old naked bright green and shining above; segments alternate, triangular, ovate along their upper edge, mucronate, the mucro projecting forwards, *Spike* (4½ inches long, 3½ broad to the extremities of the styles) terminal. *Flowers* in pairs along the rachis, forming double lines, which are much crowded together, expanding from below upwards, every where yellow, except the stigma, which is red. *Calyx* (1½ inch long) 4-parted, woolly on the outside, the woolliness increasing upwards. *Anthers* subsessile, in the oblong hollow extremities of the calyx, linear-lanceolate. *Style* longer than the calyx, curved upwards, pubescent, filiform, tumid near the extremity, tipped with the red subacute somewhat angled *Stigma.*

This very handsome species produced a fine head of flowers in the greenhouse of the Edinburgh Botanic Garden in October 1830, the plant being about five feet high.

Bolivaria.—Diandria, Monogynia. *Jasmineæ.*—Calyx 5–10-partitus, persistens. Corolla inferior, infundibuliformis, 5-fida, staminifera. Capsula gemina, circumcissa.

B. *trifida*; foliis linearibus, trisecto-pinnatifidis, integrisve.—*Schlechtendal.*

Bolivaria trifida, *Schlecht.* in Linnæa, 1826, p. 209.

Description.—*Stem* erect, slender, woody, with long, lax, slender, straggling, green, subglabrous, furrowed branches, which are opposite below, but dichotomous at the extremities. *Leaves* lanceolato-linear, glabrous, mucronate, entire or trifid at the apex, opposite, sessile, semiamplexicaul and subdecurrent, deep green, and, as well as the branches, sprinkled with minute, white, slightly elevated scales. *Flowers* solitary, terminal, or solitary in the terminal cleft of the branches. *Calyx* 5–7-parted, persisting, green, segments erect, subulate, ciliated at the base. *Corolla* (6 lines long, above 8 lines across when fully expanded) yellow, funnel-shaped, shining and rather paler on the outside, tube cylindrical, scarcely so long as the calyx, limb 5–7-parted, longer than the tube, segments elliptical, imbricated, reticulato-nerved, naked, but not shining on the inner surface, throat and inside of the tube hairy. *Stamens* 2, adhering to the inside of the tube, free above the throat, and projecting in the centre of the flower, shorter than the corolla; filaments yellow, glabrous; anthers yellow, incumbent, oblong, attenuated at both extremities, slightly notched at both, especially the lower, attached to the filaments towards one end, lobes bursting along the edges, rather distant from each other, the intervening space being green; pollen globular, yellow. *Pistil* single; style as long as the stamens, compressed laterally, slightly clavate, nearly colourless, glabrous; stigma green, capitate, large, grooved in the form of a cross on its upper surface; germen superior, smooth, obovate, channelled on both sides. *Capsule* didymous, large, membranous, thin and dry, smooth and shining, lobes obovate, circumcised, unilocular, each 4-sided. *Seeds* erect, 3-gonous, rounded on the back, flat by mutual impression on the two sides, covered with a thick cellular arillus, nucleus white, compressed, obovate, exalbuminous, covered with a thick colourless testa, radicle inferior, projecting, straight, blunt.

Mr Cruckshanks obligingly communicated seeds of this plant several years ago from the neighbourhood of Mendoza. It flowered for the first time in the greenhouse in July last, and has continued to flower almost constantly ever since.

The genus was named by Schlechtendal, with the following observation: "Genus in honorem Liberatoris, qui scientiis omnibus, scientiæque nostræ amabili Americam aperuit, diximus." He describes two species, *Bolivaria integrifolia* and *B. trifida.* Dr Gillies has among his specimens what he considers a third. The flowers are much larger than either in *B. integrifolia* or our plant; but it seems to me doubtful whether it is really specifically distinct from this last. Dr Gillies has distributed specimens under the name of *B. decemfida.* From what I have observed in *B. trifida*, and in Dr Gillies's specimens of *B. decemfida*, I suspect the divisions of the calyx and corolla vary considerably. I fear we are all apt to erect varieties into new species, in genera in which we have not long had many species in cultivation, and with the tendencies of which, therefore, we are but imperfectly acquainted. *Calceolaria bicolor* has either an erect nearly simple stem, with narrow pointed leaves, or a procumbent greatly branched stem with broad blunt leaves, according to the poverty or richness of the soil in which it is made to grow. These two forms are exhibited in the Botanical Magazine and Botanical Register of this month, and may be seen in twenty examples at the Botanic Garden; but my acute friend Professor Lindley, not adverting to this circumstance, nor to the fact that the specimens of Ruiz and Pavon grew in dry stony ground, in the very spot from whence the plants now in cultivation were obtained, has unfortunately described the latter form as a new species, under the name of *C. diffusa.*

Browallia grandiflora.

B. *grandiflora;* caule diffuso, ramoso; foliis ovatis, acutis; pedunculis axillaribus unifloris, vel in racemis terminalibus dispositis; ramulis calycibusque adultis glabris.

Description.—Annual. *Stem* herbaceous, diffused, branched, smooth, green, purplish below; branches spreading, smooth and shining, scattered. *Leaves* ovate, acuminate, attenuated into a petiole, smooth and shining, the middle rib and converging veins prominent below, and channelled above. *Peduncles* straight, single-flowered, axillary, and longer than the diminished leaves near the termination of the branches, or collected into lax terminal racemes, when young glanduloso-pubescent. *Calyx* 5-cleft, smooth, or, when young, glanduloso-villous, many-nerved, nerves branching; segments unequal, spreading, linear, channelled. *Corolla* hypocrateriform; tube longer than the calyx, slightly inflated towards the top, and compressed vertically, glanduloso-villous, greenish-yellow, marked, as well as the calyx, with dark streaks; limb plicate in the bud, when expanded flat, white, or very pale lilac, with a yellow throat, yellow on the outside, bilabiate, the upper lip linear and emarginate, the lower much larger, semicircular, formed of four united obcordato-cuneate lobes, each smaller than the upper lip. *Stamens* didynamous, adhering to the inside of the tube, the two longer closing the throat of the corolla with the upper part of their filaments, which is bent down, flattened and hairy above, their anthers included, having one perfect and one abortive lobe, divaricated, compressed, and opening along their upper edge; filaments of the shorter stamens flexuose at the top, filiform and smooth, their anthers bilobular, both the lobes perfect, divaricated and compressed, bursting along their upper edges; pollen and anthers of all the stamens yellow. *Germen* ovate, and slightly compressed, pubescent, bilocular, bivalvular, the dissepiment proceeding from the centre of the valves across the shorter diameter of the germen; seminal receptacle large, central, covered with numerous ovules. *Style* filiform, glabrous, longer than the shorter, shorter than the longer stamens, tortuose at the top. *Stigma* quadrangular, peltate, green, obscurely 4-lobed, having two depressions or cells in the upper margin, where the anthers of the longer stamens are lodged, and two obscure depressions on the lower side, where the anthers of the shorter stamens appear to be placed.

I am indebted to Dr Hooker for the description of the style and stigma, and for some observations regarding the anthers, for the style was lost in the only flower which I reserved for dissection, when the specimen was sent to him to be figured in the Botanical Magazine. The anthers on the longer and shorter stamens appeared to him to be alike, reniform, and 1-celled; but I am quite certain that the above description of what I saw is accurate: the appearance probably varies from abortion, and in different stages of evolution.

We received this plant from the Botanic Garden, Glasgow, in October last, having been raised there from seeds collected by Mr Cruckshanks near Yazo, in the valley of Canta in Peru. It is now (December) flowering very freely in the greenhouse, and probably will be found to bear cultivation as a very ornamental annual in the open border.

Conobea alata.

C. *alata;* caule erecto, alato; foliis lanceolatis, amplexicaulibus, serrulatis, breve pubescentibus, pedunculo axillari solitario subcymoso multo longioribus.

Description.—*Root* creeping. *Stem* (2½ feet high) erect, glabrous, shining, 4-sided, 4-winged, wings undulate, and sparingly ciliated. *Branches* decussating, spreading wide, similar to the stem. *Leaves* (10 inches long, 2 broad) opposite, spreading horizontally, acutely serrulate, lanceolate, attenuated and entire towards the base, at their origin dilated, and stem clasping, much veined and reticulated, soft, and on both sides covered with very short pubescence, bright green above, somewhat glaucous below, middle rib very strong, and with the veins prominent below. *Peduncles* axillary, opposite, 4-sided, closely applied to the upper surface of the leaves, and (including the pedicels) about a fifth of their length, pubescent, bracteate, trifid, the lateral branches again dividing in the same way; pedicels like the peduncle, but less distinctly angled. *Bracteæ* lanceolate, entire, acuminate. *Calyx* green, oblique, 5-ribbed, 5-toothed, pubescent on the outside, persisting. *Corolla* (8 lines long, 4½ across) yellow, bilabiate; tube elongated, compressed laterally in its lower, vertically in its upper half, nearly thrice the length of the calyx; upper lip bifid, revolute, lower lip spreading forwards, plicate, trifid, revolute at the apices, all the lobes rounded; two very prominent ridges, very hairy, and somewhat orange-coloured, extend backwards into the corolla from the central lobe of the lower lip. *Stamens* didynamous, included; filaments glabrous, yellow, adhering to the corolla for about half their length, connivent; anthers bilobular, lobes divergent; pollen white. *Pistil* as long as the stamens; stigma bifid, white, lobes broad, revolute, upper surface pubescent; style straight, white, filiform, glabrous, marcescent; germen ovate, green, glabrous, 4-valved, bilocular; ovules very numerous, attached to a large central receptacle, a transverse section of which presents a kidney-shaped surface in each loculament.

This plant was raised in the garden of P. Neill, Esq. at Canonmills, from Mexican seeds communicated by Mr D. Don as a species of *Conobea*, and flowered in the greenhouse in September.

Loasa incana.

L. *incana;* suffruticosa, suburens; caule suberecto, ramoso, foliisque sparsis, petiolatis ovato-lanceolatis, inciso-serratis, incano, scabro; pedunculis simplicibus oppositifoliis.

Description.—Suffruticose. Whole *plant*, particularly the stem, densely covered with harsh barbed white hairs, and a few stinging hairs interspersed. *Stem* round, much branched, branches scattered, spreading. *Cuticle* papery, and peeling off in the dried specimen. *Leaves* scattered, petioled, spreading, ovate, acute, hispid on both sides, veined, incise-serrated, veins and midrib prominent below, channelled above. *Flowers* opposite the leaves, solitary, peduncled. *Peduncles* spreading, about half the length of the leaves, round. *Calyx* green, spread wide, segments ovato-acuminate, 3-ribbed, undulate, reflected in their sides, persisting. *Corolla* white, 10-parted, uniseriate, alternate, segments alike, the larger segments spreading, cucullate, nerved and veined, longer than the calyx; the smaller segments nearly glabrous, slightly ciliated, concave within, nectariferous, each having near its rounded apex three erect dorsal filaments as long as itself. *Stamens* numerous, nearly as long as the longer segments of the corolla, and lodged within them till the pollen is ripe, when they become erect, free, unconnected with each other, mostly perfect, with simple, colourless, slightly flattened, glabrous filaments, and greenish-yellow, oblong, bilocular anthers, erect, bursting along the sides; 10 barren, 2 within each of the shorter petals, spreading and flattened at the base, there ciliated, each having a reflected lip at the apex of the petal within which it is placed, and above this extended into an erect filament, nearly as long as the fertile stamens. *Style* erect, simple, shorter than the stamens, tapering, nearly smooth towards the top. *Stigma* capitate, small, lobed, smooth. *Germen* top-shaped, inferior, green, unilocular, with 3–4 parietal receptacles, alternate with the teeth, covered along their edge with numerous ovules. *Capsule* opening by 3-4 teeth above the level of the calyx. *Seeds* obovato-oblong, minute, brown, pitted, embryo straight.

This plant was raised from seeds communicated in spring last from Yazo, valley of Canta, in Peru. Mr Cruckshanks only observed one plant, low and branching, with the branches much entangled. From this he also most kindly presented me with a well dried specimen, from which, rather than from our plant (we raised but one), which is still small, it appears to flower very freely. With us it flowered in the greenhouse during October and November, and even now (7th December) there are buds which may possibly expand.

Lophospermum erubescens.

L. *erubescens;* foliis triangulari-cordatis, grosse inæqualiterque serratis (melius, inæqualiter inciso-dentatis), pubescentibus, calycis segmentis oblongis mucronulatis, filamentis simplicibus.—*D. Don.*

Lophospermum erubescens, *D. Don, Sweet's* Brit. Fl. Gard. N. S. fol. 75. (on Helianthus petiolaris), Note.

Lophospermum scandens, Bot. Mag. 3037-8.—*Sweet's* Brit. Fl. Gard. N. S. t. 68.

Description.—*Plant* herbaceous, scandent chiefly by the petioles. *Stem* round, brownish-green, in a very luxuriant state pushing roots from near the base, cuticle smooth, or somewhat cracked. *Branches* round, opposite, villous, purple at the base, young shoots green. *Leaves* (5½ inches from the base to the apex, rather more across) numerous, opposite, petioled, deltoideo-cordate, acute, incise-toothed, villous on both sides, bright green above, paler below, 3-nerved, the lateral nerves branched, slightly reticulated chiefly at the margins, teeth mucronate. *Petioles* purple, villous, as long as the leaf, stout, round, scarcely channelled above, twisting. *Peduncles* axillary, solitary, single-flowered, ebracteate, as long as the petioles, erect, straight, green, villous. *Flowers* spreading horizontally. *Calyx* foliaceous, 5-parted, persisting, segments (1 inch long, ½ inch broad) subequal, the upper rather the shortest and broadest, ovate, acute, prominent at the edges, veined, pubescent within and without, sometimes becoming purple, entire or rarely auricled at the base. *Corolla* (nearly 3 inches long, 2 inches across) rose-coloured, pubescent every where on the outside, campanulate, slightly turgid below; tube elongated, slightly curved downwards, dilated, nectariferous, and nearly colourless at the base, darkest on the upper side, within freckled with rose-colour, and having yellow pubescence towards the insertion of the stamens; limb spreading, 5-parted, segments rounded, subequal, the lowest the smallest, the two upper the largest; from the base of the lower segment upon each side, a straight ridge, covered with erect yellowish hairs, extends to the insertion of the two longer stamens. *Stamens* 4, didynamous, as long as the tube, from the base of which they arise; filaments compressed, and adhering for a little way to the corolla, and there closing the tube, coarsely pubescent where they become free, at this part purple on the back, beautifully sprinkled with rose-coloured spots or streaks, from which springs glandular pubescence, especially on the sides of their upper half, straight, diverging slightly, connivent towards their extremities; anthers large, bilobular, glabrous, lobes parallel in the bud, afterwards divaricated, bursting along their sides; pollen white, granules small. There is a minute, abortive, fifth stamen, between the two shorter perfect ones at their origin. *Pistil* as long as the stamens; stigma simple, bent nearly at a right angle with the style, colourless, pointed; style straight, filiform, smooth above, sparingly provided with glandular pubescence in its lower half, base persisting; germen seated upon a prominent white glabrous and shining receptacle, densely covered with erect colourless glandular hairs, bilocular. *Unripe capsule* crown-shaped, green, colourless at the base, somewhat compressed and furrowed laterally, covered with glandular pubescence, undulate, terminated with the persisting base of the style, included within the calyx. *Ovules* numerous, imbricated, tubercled, stipitate, erect on two large central receptacles, winged all round; wing radiated, emarginate, somewhat ragged in its edge; nucleus pendulous, pointed below, albumen large, embryo straight, central.

This beautiful creeper was raised by P. Neill, Esq. in his garden at Canonmills, from Mexican seed last spring. It flowered in his stove in the beginning, and in the greenhouse of the Botanic Garden, Edinburgh, in the middle of September. Plants were also exposed in the open border, and flower-buds formed freely there, but too late in the season to be expanded. If turned out earlier, it is possible we may see it forming a noble addition to our half hardy plants.

It was upon Mr Don's authority that in the Botanical Magazine I gave to this plant the MS. specific name of Sesse and Mocinno. The reasons subsequently assigned by him (loc. cit.) for considering it a new species seem perfectly conclusive. I however find the pubescence always articulate.

Michauxia lævigata.

M. *lævigata;* caule elato, glaberrimo, nitido; foliis duplicato-dentatis, hispidis, radicalibus ovatis longe petiolatis, caulinis sessilibus oblongis, inferioribus base attenuatis, superioribus cordatis; floribus decandris; stigma, calyce, corollaque 10-partitis.

Michauxia lævigata, *Vent.* Hort. Cels. p. 81. t. 81.—*Persoon,* Synop. 1. 418.—*Sprengel,* Syst. Veget. 2. 213.
Michauxia decandra, *Fischer,* MS.

Description.—*Root* perennial. *Stem* (11 feet high) herbaceous, smooth, shining, tapering, subsimple, upright, straight. *Leaves* sprinkled on both sides with harsh erect hairs, duplicato-dentate, coarsely veined and reticulate; *root-leaves* ovate, decurrent along petioles longer than themselves, and on the upper part of which there are a few small pinnæ; *stem-leaves* sessile, the lower ones oblong, and somewhat attenuated at the base, higher up cordate, and more acute, and gradually passing into cordate, acute *bracteæ,* with reflected aculei on the margin and on the back of the middle rib. *Flowers* scattered along nearly the whole length of the stem, on short peduncles in the axils of the bracteæ, expand in succession, and slowly, from below upwards. *Peduncles* solitary, bearing three flowers, of which the terminal only expands with us. *Calyx* of ten segments, which are acute, at first erect, afterwards spreading at right angles, reflected in the sides, and fringed with reflected aculei, and of ten other segments, which extend backwards along the pedicel, flat and shorter, but in other respects similar to the first ten, and alternating with them. *Corolla* white, much longer than the calyx, 10-parted, segments (1 inch long, 1 line broad) linear, revolute, reflected in their edges, and ciliated with reflected aculei along the middle rib. *Stamens* 10; filaments connivent, subulate, winged, wings reflected villous; anthers as long as the filaments, linear, yellow, bursting along the sides; pollen yellow. *Germen* top-shaped, inferior, ribbed, 10-locular. *Style* stout, straight, longer than the stamens, pubescent. *Stigma* 10-parted, revolute. *Ovules* very numerous, attached to a large central receptacle. The whole plant yields, on the slightest injury, a large quantity of milky juice.

Seeds of this plant, which is a native of the north of Persia, were communicated to the Botanic Garden, Edinburgh, by Dr Fischer in March 1829, and the same specimen has been in flower with us for about two months after the middle of August. Even yet (16th October), the flowers have not expanded much above half-way up the stem, and I have no doubt it would have continued in blossom till the frost cut it down, but for an injury which it has received. I had hoped to have received Ventenat's work before this description was printed, but as I have not, the identity of our plant with his may admit of some doubt; but I cannot believe that they are different.

Phalangium longifolium.

P. *longifolium;* caule simplice, folioso; floribus laxe racemosis, nutantibus; pedunculis congestis, medio articulatis, bracteam acuminatam æquantibus; petalis acutis; filamentis medio tumidis; foliis linearibus, glabris, denticulatis, caulem subæquantibus.

Description.—*Root* fascicled, drawn out into long fibres, swelling into oblong, white, villous tubers. *Stem* (2½ feet high) simple, round, glabrous, leafy. *Root-leaves* numerous, lanceolato-linear, channelled, glabrous, ciliato-denticulate, flaccid, about as long as the stem. *Stem-leaves* similar to the others, but gradually smaller, and passing into bracteæ upwards, scattered, and stem clasping, acuminate. *Bracteæ* dilated at the base, membranous at the edges, acute; secondary smaller ones within the larger. *Flowers* in long, lax, terminal racemes, nodding. *Peduncles* clustered, glabrous, jointed in the middle, dark green in their lower half, paler in the upper. *Corolla* (1¼ inch across, when fully expanded) white, of six, wide spread, 3-nerved, oblong, acute, petals, of which the three outer are narrowest. *Stamens* half the length of the corolla; filaments tumid above the middle, glabrous; anthers orange-yellow, as long as the filaments, emarginate at the apex, notched at the base, bursting along the sides; pollen very abundant, orange-yellow. *Pistil* rather longer than the stamens; stigma pubescent; style declined; germen linear, trigonous, trivalvular, trilocular, dissepiments arising from the centre of the valves. *Ovules* attached to a central receptacle, and arranged in two rows in each cell.

Bulbs of this species were brought from Lima last spring by Mr Cruckshanks, under the generic name of *Ornithogalum*, and flowered in the stove of the Botanic Garden, Edinburgh, in September.

Celestial Phenomena from January 1. *to April* 1. 1831, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Astronomical Calculator, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight —The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

JANUARY.

D.	H.	′	″		D.	H.	′	″	
2.	4	21	36	☌ ☽ α ♌	20.	17	31	35	☉ enters ♒
2.	11	59	40	☌ ☽ ♄	20	19	9	7	☌ ☽ ν ♓
2.	15	46	8	☌ ☽ ρ ♌	20.	22	28	37	☌ ☽ ♂
3.	15	13	10	☌ ☽ σ ♌	21.	7	26	59	☽ First Quarter.
3.	22	15	23	☌ ♂ ζ ♓	21.	15	49	31	☌ ☽ 2 ξ Ceti.
5.	8	24	53	☌ ☽ 1 γ ♍	21.	23	4	41	☌ ☽ μ Ceti.
5.	22	47	24	☾ Last Quarter.	22.	15	50	–	☌ ♀ ♅
9.	2	51	52	☌ ☽ γ ♎	22.	18	39	22	☌ ☽ f ♉
9.	14	15	43	☌ ☽ ψ ♎	23.	0	30	–	☌ ☿ ♀
10.	6	26	6	☌ ☽ φ Oph.	23.	14	53	5	☌ ☽ γ ♉
11.	1	14	–	☿ greatest elong.	23.	16	7	9	☌ ☽ 1 δ ♉
11.	10	32	16	☌ ☿ ♅	23.	16	35	45	☌ ☽ 2 δ ♉
13.	6	20	41	☌ ♀ ♃	23.	21	28	51	☌ ♀ δ ♑
13.	12	6	56	☌ ☽ d ♐	23.	21	36	28	☌ ☽ α ♉
14.	1	33	9	● New Moon.	26.	17	41	–	Inf. ☌ ☉ ☿
14.	8	45	–	☌ ☿ δ ♑	28.	2	33	26	○ Full Moon.
14.	12	23	40	☌ ☽ ♃	29.	14	20	38	☌ ☽ α ♌
14.	15	10	45	☌ ☽ ♀	29.	19	12	20	☌ ☽ ♄
15.	9	20	45	☌ ☽ ♅	30.	1	36	18	☌ ☽ ρ ♌
15.	14	23	–	☌ ☽ ☿	30.	4	53	17	☌ ♀ γ ♑
17.	13	40	50	☌ ☽ λ ♒	31.	0	38	–	☌ ☉ ♅
17.	23	42	27	☌ ☽ φ ♒	31.	0	39	58	☌ ☽ σ ♌
20.	11	30	–	☌ ☉ ♃					

FEBRUARY.

D.	H.	′	″	
1.	2	35	31	☌ ♀ δ ♑
1.	17	6	14	☌ ☽ 1 γ ♍
4.	20	14	2	☾ Last Quarter.
5.	10	52	21	☌ ☽ γ ≏
5.	22	16	27	☌ ☽ ψ ≏
6.	14	32	14	☌ ☽ φ Oph.
9.	20	26	7	☌ ☽ d ♐
10.	18	32	–	☌ ☽ ☿
11.	8	54	42	☌ ☽ ♃
11.	20	19	33	☌ ☽ ♅
12.	17	0	26	● New Moon.
13.	18	8	34	☌ ☽ ♀
13.	20	48	30	☌ ☽ λ ♒
14.	6	35	35	☌ ☽ φ ♒
14.	23	6	33	☌ ♀ λ ♒
17.	0	39	4	☌ ☽ ν ♓
17.	4	48	26	☌ ♅ δ ♑
17.	16	17	–	☍ ☉ ♄
17.	21	9	3	☌ ☽ 2 ξ Ceti.
18.	4	23	8	☌ ☽ μ Ceti.
18.	8	33	43	☌ ☽ ♂
18.	20	57	21	Em. III. sat. ♃
19.	0	1	40	☌ ☽ f ♉
19.	8	14	0	☉ enters ♓
19.	15	0	17	☽ First Quarter.
19.	15	24	18	☌ ♀ φ ♒
19.	20	29	23	☌ ☽ γ ♉
19.	22	14	31	☌ ☽ 2 δ ♉
20.	3	9	19	☌ ☽ α ♉
20.	15	34	–	☿ greatest elong.
23.	5	36	–	☿ *very near* ♃
25.	1	54	8	☌ ♂ δ ♈
25.	23	11	19	☌ ☽ α ♌
26.	0	18	57	☌ ☽ ♄
26.	0	57	3	Em. III. sat. ♃
26.	10	32	55	☌ ☽ ρ ♌
26.	13	45	–	☌ ☿ ϑ ♑
26.	16	50	12	○ Full Moon.
27.	3	5	20	☌ ☿ ♅
27.	9	41	8	☌ ☽ σ ♌

MARCH.

D.	H.	′	″	
1.	1	56	11	☌ ☽ 1 γ ♍
4.	19	2	6	☌ ☽ γ ≏
5.	0	4	–	☌ ☿ γ ♑
5.	4	48	–	☌ ☿ δ ♑
5.	4	56	33	Em. III. sat. ♃
5.	6	28	19	☌ ☽ ψ ≏
5.	22	47	21	☌ ☽ φ Oph.
6.	7	56	34	☌ ♄ α ♌
6.	17	9	51	☾ Last Quarter.
9.	5	32	43	☌ ☽ d ♐
9.	8	55	55	Em. III. sat. ♃
11.	5	41	41	☌ ☽ ♃
11.	8	29	47	☌ ☽ ♅
12.	17	46	–	☌ ☽ ☿
13.	4	12	7	☌ ♃ δ ♑
13.	6	8	31	☌ ☽ λ ♒
14.	5	45	56	● New Moon.
15.	15	53	34	☌ ☽ ♀
16.	8	11	1	☌ ☽ ν ♓
17.	4	14	22	☌ ☽ 2 ξ Ceti.
17.	11	5	59	☌ ☽ μ Ceti.
17.	21	32	14	☌ ♀ ζ ♓
17.	22	56	34	♂ *very near* A ♉
18.	6	13	39	☌ ☽ f ♉
18.	20	53	27	☌ ☽ ♂
19.	2	15	42	☌ ☽ γ ♉
19.	3	29	42	☌ ☽ 1 δ ♉
19.	3	58	14	☌ ☽ 2 δ ♉
19.	8	49	11	☌ ☽ α ♉
20.	16	44	–	☌ ☿ φ ♒
20.	22	12	28	☽ First Quarter.
21.	1	25	39	☌ ♃ ♅
21.	8	14	50	☉ enters ♈
24.	18	3	6	☌ ♀ ο ♓
25.	3	42	43	☌ ☽ ♄
25.	5	57	35	☌ ☽ α ♌
25.	17	31	36	☌ ☽ ρ ♌
26.	17	2	10	☌ ☽ σ ♌
28.	8	13	52	○ Full Moon.
28.	9	40	48	☌ ☽ 1 γ ♍

Times of the Planets passing the Meridian, and their Declination.

JANUARY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	13 14	22 49 S.	12 16	23 34 S.	18 18	6 50 N.	13 8	21 27 S.	3 36	12 23 N.	14 4	18 40 S.
5	13 22	21 11	12 21	23 4	18 10	7 45	12 55	21 17	3 20	12 27	13 49	18 37
10	13 28	18 51	12 29	22 14	18 1	8 53	12 41	21 4	3 0	12 33	13 30	18 32
15	13 21	16 39	12 36	21 7	17 52	10 2	12 26	20 50	2 39	12 40	13 12	18 28
20	12 59	15 18	12 43	19 46	17 42	11 9	12 12	20 36	2 18	12 47	12 53	18 23
25	12 21	15 15	12 49	18 10	17 34	12 16	11 57	20 22	1 56	12 55	12 34	18 18

FEBRUARY.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	11 20	16 50 S.	12 56	15 32 S.	17 22	13 47 N.	11 36	20 0 S.	1 27	13 7 N.	12 10	18 11 S.
5	10 57	17 50	13 0	13 53	17 15	14 38	11 24	19 48	1 11	13 13	11 54	18 8
10	10 33	18 42	13 4	11 40	17 8	15 38	11 9	19 32	0 50	13 22	11 36	18 4
15	10 29	19 8	13 8	9 20	17 0	16 37	10 55	19 15	0 28	13 31	11 17	17 59
20	10 29	19 2	13 11	6 53	16 51	17 34	10 39	18 59	0 7	13 40	10 58	17 54
25	10 32	1824	13 14	4 22	16 44	18 29	10 24	18 42	23 42	13 50	10 39	17 49

MARCH.

	Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Georgian.	
D.	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′	H. ′	° ′
1	10 37	17 31 S.	13 17	2 20 S.	16 39	19 9 N.	10 13	18 29 S.	23 25	13 57 N.	10 25	17 46 S.
5	10 43	16 30	13 19	0 16	16 33	19 48	10 0	18 16	23 8	14 3	10 11	17 43
10	10 53	14 9	13 22	2 19 N.	16 26	20 35	9 45	17 59	22 47	14 11	9 52	17 39
15	11 3	11 37	13 25	4 53	16 19	21 18	9 29	17 42	22 26	14 18	9 33	17 35
20	11 15	8 26	13 28	7 25	16 12	21 58	9 14	17 26	22 5	14 24	9 15	17 31
25	11 27	4 51	13 31	9 53	16 5	22 33	8 58	17 10	21 44	14 30	8 56	17 27

Proceedings of the Wernerian Natural History Society.

1830, *Dec.* 11.—Robert Jameson, Esq. P. in the chair.—The Rev. Dr Scot of Corstorphine read a learned essay on the "giants" mentioned in the Sacred Writings. The Secretary read a communication from James Wilson, Esq. giving an account of the great Orang-outang of Sumatra, illustrated by figures of the hand and foot, of the natural size. Professor Jameson then gave an account of Dr Gregory's analysis of the compact ferruginous marl of the old red sandstone of Salisbury Crags; and also of the same gentleman's analysis of the limestone of the Red Burn near Seafield Tower in Fife, which is magnesian, but only where in contact with the trap. The Professor also communicated some details in regard to Captain Ross's expedition, and the splendid display of polar lights observed in the Shetland Islands in the month of November last. A sketch of the magnificent fossil tree, at present seen *in situ* in Craigleith Quarry, with a cross-section of a portion of the stem, exhibiting very nearly the structure of a coniferous tree, was exhibited to the meeting.

At this meeting, the following gentlemen were elected office-bearers of the Society for 1831.

Robert Jameson, Esq. *President.*

Vice-Presidents.

R. K. Greville, LL. D.
David Falconar, Esq.
John Boggie, M. D.
Alex. Brunton, D. D.

Secretary, Pat. Neill, Esq.
Treasurer, A. G. Ellis, Esq.
Librarian, James Wilson, Esq.
Painter, P. Syme, Esq.

Council.

John Stark, Esq.
Sir Arthur Nicholson, Bart.
John Gillies, M. D.
Rev. David Scot, M. D.
Charles Anderson, M. D.
W. C. Trevelyan, Esq.
Mark Watt, Esq.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Heavy fall of Rain, and frequent appearance of Aurora Borealis, in September* 1830.—At the Calf of Man Low Lighthouse, on the morning of the 16th September, there was a remarkably heavy fall of rain. "In the course of little more than four hours (says Mr James Macintosh, the light-keeper), I found *ninety* parts in the gauge. At a quarter past eleven o'clock P. M. it began lightly, and it gradually increased till twelve, when it came down in torrents. This continued till near four o'clock in the morning, when the rain entirely ceased. Although it blew a gale that day, there was not a breath of wind during the fall of rain, but the wind rose immediately afterwards. The Edinburgh Chronicle takes notice of floods in several places in Scotland, of the same date; so I presume we had the first of the heavy rain here, as the direction of the wind, both before and after the rain, was from the S. W. During the course of this September (adds Mr Macintosh), I have to record no fewer than nine appearances of the aurora borealis, the dates being the 7th, 10th, 12th, 13th, 17th, 19th, 20th, 21st, and 25th."

2. *Water Spout in the Lake of Neufchatel.*—On the 9th June, at nine o'clock in the morning, the weather being moist, and the thermometer at 64° Fahr. a water-spout was seen at Neufchatel, on the other side of the lake, about a league from the fort. From a fixed black cloud, about eighty feet above the surface, descended perpendicularly a dark-grey cylindrical column, touching the surface of the lake. Much agitation was seen at the foot and top of the column, a dull heavy sound was heard, and the waters of the lake were seen to mount rapidly along this sort of syphon to the cloud, which gradually became white as it received them. After seven or eight minutes had elapsed, a north-east wind pressed upon the column, so that it bent in the middle, still however raising water, until at last it separated. At the same moment, the cloud above, agitated and compressed by the wind, burst and let fall a deluge of rain.

This appearance was neither preceded nor followed by any lightning or explosion; the column was vertical and motionless, no rotary motion being observed.—*Bib. Univ. June* 1830.

3. *Polar Lights in Shetland.*—We are informed by our former pupil Mr Mouat Cameron, that the Polar lights had been uncommonly frequent and brilliant during the latter part of last summer and during the whole of autumn. On the 15th of November they were most splendid, exhibiting an appearance which the oldest man in the country had never witnessed. "I can compare it," says Mr Cameron, "to nothing but the light thrown out from a foundry at work, supposing the horizon to represent the mouth of the furnace—and even this conveys but a feeble idea of its appearance." The Polar lights, we may add, have been very frequent and brilliant in this neighbourhood. This atmospheric luminous meteor appears, for these some years past, to be running through one of its maximum periods.

4. *Nitrous Atmosphere of Tirhoot.*—Tirhoot is one of the principal districts in India for the manufacture of saltpetre; the soil is every where abundantly impregnated with this substance, and it floats in the atmosphere in such quantities, that, during the rains and cold weather, it is attracted from thence by the lime on the damp walls of houses, and fixes there in shape of long downy crystals of exceeding delicacy. From damp spots it may be brushed off every two or three days almost in basketsful. In consequence of all this, the ground, even in hot weather, is so damp, that it is extremely difficult either to get earth of sufficient tenacity to make bricks (the country being quite destitute of stones), or, when made, to find a spot sufficiently solid to sustain the weight of a house. Even with the greatest care the ground at last yields, and the saltpetre corrodes the best of the bricks to such a degree, that the whole house gradually sinks several inches below its original level. Houses built of inferior materials, of course suffer much more; one, of which the inner foundations were of unburnt bricks, absolutely fell down whilst I was at Mullye, and the family in it escaped almost by miracle. My own house, which was not much better, sank so much, and the walls were at bottom so evidently giving way, that I

was compelled, with extreme expense and inconvenience, to pull down the whole inner walls, and build them afresh in a more secure manner. From the same cause, a new magazine which government directed to be built, with an arched roof of brick-work, was, when complete, found so very unsafe, that it was necessary to demolish it entirely, and rebuild it on a new plan, with a roof of tiles. In such a soil, it will easily be concluded that swamps and lagoons prevail very much, of course, mostly during the rains, and till the sun gathers power in the hot weather; and, in fact, what has been above so much insisted on, as to the two contrary aspects of the country with respect to vegetation, may, by a conversion of terms, be equally applied to the water on its surface. In the cold and dry weather it is comparatively scanty, in the rains it is superabundant; and as the rivers in this district are frequently found to change their situations, so, through a long course of time, it has resulted that hollow beds, being deserted by their streams, become transformed into what, during the rains, assume the appearance of extensive lakes, but in dry weather degenerate into mere muddy swamps, overgrown with a profusion of rank aquatic vegetations, particularly the gigantic leaves of the lotus, and swarming with every tribe of loathsome cold-blooded animals. Some of these lakes, during the height of the rains, communicate with their original streams, and thus undergo a temporary purification; but others receive no fresh supply except from the clouds, and of course their condition is by much the worse. Some of the conversions of a river-bed into a lake, have occurred in the memory of the present inhabitants, or at least within one descent from their ancestors.—*Tytler, on the Climate of Mullye, in Trans. Med. & Phys. Soc. of Calcutta*, vol. iv.

GEOLOGY.

5. *Heights of Table Lands.*

	Toises above the sea.
The table land of Iran in Persia, - -	650
Table land in which Moscow is situated, -	67
The plain of Lombardy, - - -	80
Table land of Swabia, - - -	150
——— Auvergne, - - -	174
——— Schweitz, - - -	220
——— Bavaria, - - -	260
——— Spain, - - -	350

These table lands are not longitudinal valleys between ranges of mountains. The bottom of a longitudinal valley, which is from 1500 to 2000 toises above the sea, as is the case in the Andes, is caused by the elevation of a whole *mountain chain.* True table lands, such as those of Spain and Bavaria, were probably formed by the upraising of a whole *continental mass.* Both epochas are geognostically considered different.—*Humboldt.*

6. *Lake Aral.*—The surface of the lake Aral is 117 feet higher than that of the Caspian.—*Humboldt.*

7. *Fossil Shells in the Snowy Mountains of Thibet.*—At a meeting of the Asiatic Society of Calcutta, on 5th May last, extracts from Mr Gerard's letters, relative to the fossil shells collected by him in his late tour over the snowy mountains of the Thibet frontier, were read. The loftiest altitude at which he picked up some of them, was on the crest of a pass, elevated 17,000 feet; and here also were fragments of rock, bearing the impressions of shells, which must have been detached from the contiguous peaks rising far above the elevated level. Generally, however, the rocks formed of these shells are at an altitude of 16,000 feet, *and one cliff was a mile in perpendicular height above the nearest level.* Mr Gerard farther states, "Just before crossing the boundary of Ludak into Bussahir, I was exceedingly gratified by the discovery of a bed of fossil oysters, clinging to the rock as if they had been alive." In whatever point of view we are to consider the subject, it is sublime to think of millions of organic remains lying at such an extraordinary altitude, and of vast cliffs of rocks formed out of them, frowning over these illimitable and desolate wastes, where the ocean once rolled.—*Asiatic Register.*

8. *Bone Caves discovered in New Holland.*—Colonel Lindsay of the 39th Regiment, a very active and intelligent inquirer, informs us of the discovery of great quantities of fossil bones of animals, imbedded in marl and other substances, in caves in New Holland. Some of these animals (quadrupeds), judging from the size of the bones, must have been very large,—a circumstance the more remarkable, because hitherto no large quadrupeds have been found in Australia.

9. *Leonhard on the Basaltic Formation.*—Professor Leonhard of Heidelberg informs us, that he has now in the press a work

on Basaltic or Trap rocks, which will appear in two volumes octavo, with numerous sections and maps. It will, from a printed prospectus sent to us, be the most complete work on this very interesting subject which has hitherto been presented to the public. It will appear during the course of 1831.

ZOOLOGY.

10. *On the Existence of Animalcula in Snow.*—The following account was sent by Dr J. E. Mure, in a letter to Dr Silliman.—When the winter had made considerable progress, without much frost, there happened a heavy fall of snow. Apprehending that I might not have an opportunity of filling my house with ice, I threw in snow, perhaps enough to fill it. There was afterwards severely cold weather, and I filled the remainder with ice. About August, the waste and consumption of the ice brought us down to the snow, when it was discovered that a glass of water which was cooled with it, contained hundreds of animalcules. I then examined another glass of water out of the same pitcher, and, with the aid of a microscope, before the snow was put into it, found it perfectly clear and pure; the snow was then thrown into it, and, on solution, the water again exhibited the same phenomenon, hundreds of animalcules, visible to the naked eye with acute attention, and, when viewed through the microscope, resembling most diminutive shrimps, and wholly unlike the eels discovered in the acetous acid, were seen in the full enjoyment of animated nature. I caused holes to be dug in several parts of the mass of snow in the ice-house, and to the centre of it, and, in the most unequivocal and repeated experiments, had similar results; so that my family did not again venture to introduce the snow-ice into the water they drank, which had been a favourite method, but used it as an external refrigerant for the pitcher. These little animals may class with the amphibia which have cold blood, and are generally capable, in a low temperature, of a torpid state of existence. Hence their icy immersion did no violence to their constitution, and the possibility of their revival by heat is well sustained by analogy; but their generation, their parentage, and their extraordinary transmigration, are to me subjects of profound astonishment.

11. *Mr Marshall on a Heifer which yielded Milk.—Edrington, by Berwick, June* 16. 1830.—Sir, As I believe the following fact, which I shall have the honour of narrating to you, to be a very uncommon one, I have from that consideration been induced to trouble you with its communication. I have two two-years-old heifers, one of which has been observed for several months to suck the other, and evidently to draw a certain portion of milk. This circumstance rendering it necessary to separate them, curiosity suggested the trial whether the heifer which had played nurse would yield milk to the hand. On the experiment being made, she gave a full English quart of genuine milk; and on the milk being kept for thirty hours, it was covered with a coat of very good cream. The cream being churned in a bottle, afforded as much, and as good, butter, as the same quantity of any other cream would have done, under similar management. The singular part of the story is, that the heifer in question has never seen the bull. I am aware that a bitch kept up from the dog will, at the time she should have produced puppies, have milk in her dugs, but I do not know of any other female that secretes milk without being impregnated. I have the honour to be, &c. Jos. Marshall. *To Professor Jameson.*

12. *Frog and Insect Plague of Mullye*—As a further illustration of the nature of the atmosphere and climate in general, I shall add the following observations, which may be of some use in a medical point of view. During the rains, the vast abundance of cold-blooded animals is really astonishing. Of these, frogs are the most numerous. No place is free from this plague; every hole and every corner, both of the most retired and most public rooms, are equally infested. If a table, a chest of drawers, or a box be moved, or a carpet be lifted, they are found nestled underneath by fifteen or twenty in each corner; and thus through our halls, our bed-rooms, and our sitting rooms. There they remain during the day; and towards sunset, they begin to issue from their ambuscades, and traverse the whole house in quest of prey. The following anecdotes may give some idea of the number of insects. One morning at sunrise, I was awakened by a loud humming in my bedroom, resembling that of a market or fair held at a distance. On examination, my window was darkened, and my bed covered

with an Egyptian swarm of gigantic winged ants, about 1¼ inches long, and of a dark red colour, and the thickness of a crow-quill, issuing, in an uninterrupted stream, from a hole between the square tiles of the floor. Such swarms are very common, and the air is then crowded with crows and hawks that come to devour. One day, about an hour after sunset, we were alarmed from without, by what seemed an excessively heavy fall of rain pouring in torrents. On inquiry, the night was perfectly clear. Curiosity led me to go out with a light to examine the cause. I found it proceeded from an almost inconceivable number of black beetles issuing from the ground: they were somewhat larger than the first phalanx of the thumb, and their aggregated hum was the sound we had heard. To say they were coming from the earth in thousands, or tens of thousands, scarcely gives an adequate idea of their production. They must be conceived as issuing in a continued torrent from every inch over the ground, and filling the atmosphere with their flight.—I shall give one other instance, which to me was peculiarly interesting, and on that account, perhaps, more observed by myself than by others. Mullye produces above all other places those insects which are destructive to books and papers. Notwithstanding the utmost care, exposure, and cleanliness, the outside of books appears perforated with small holes, as if by a pin, and apparently made for the entrance of a small species of white worms, about a quarter of an inch long; colonies of which, having thus got entrance among the leaves, there revel in destruction. They eat in serpentine labyrinths, till the whole book is traversed through and through, and destroyed. Happily they seem to have a dislike to ink, and seldom attack the printed part of the leaves till they have previously feasted on the margin. At other stations, occasional examination of the shelves, and opening the volumes, was sufficient to stop the invaders; but at Mullye, no precaution whatever had any influence in restraining their ravages. I may also add, that it was invariably necessary to alter the disposition of my library in the dry and rainy weather. It is no exaggeration to say that books of all kinds became, in the latter season, so swelled with moisture, that a shelf cannot then hold more than three volumes out of the four that it easily contains in the dry part of the year; books bound with ill-seasoned, particularly with Hindoostanee, leather, and still more especially, if left to lie neglected on a table for a day or two, become covered with a stratum of white mould, at least an eighth of an inch thick; and an approach to this takes place even in the best European leather. The boards are then soaked through with moisture, whilst, in the hot winds, they are parched and rolled, as if held before a fire. Of course, all this renders their preservation extremely difficult. After this, I leave it to be imagined, that the moths among cloths, and the omnivorous white ants among almost every thing, but particularly the timber of buildings, are fully proportioned in numbers to their kindred plagues. The last thing I have to mention, though it may appear in some degree ridiculous, may yet serve to illustrate the nature of the climate. Small mushrooms grow in every corner that is the least neglected, even in the most frequented rooms: left to themselves, they would attain the height of about two inches, with a top rather larger than a shilling; but they are generally discovered and brushed away before they reach maturity.—*Tytler, in Trans. of Med. & Phys. Soc. of Calcutta*, vol. iv.

13. *Further notice of Ehrenberg's Observations on the Infusoria.*—One of our late pupils, in a letter to Dr Duncan, says, "As you may well suppose, I prized highly the kindness with which Professor Ehrenberg of Berlin explained to me his different discoveries and researches. He spent nearly a whole forenoon in showing me the structure of the infusory animals; his investigations and drawings are what excited so much interest at the meeting of naturalists in Hamburgh. In these minute creatures, placed at the extremity of the animal scale, the determination of whose existence merely has hitherto formed the limit of zoological research, he has succeeded in developing a complete system of organs, by using one of Chevalier's microscopes, of 2000 powers. These animals are quite transparent; so that the whole internal structure is visible externally. They have one or more stomachs, mouth, œsophagus, intestinal canal, anus, eyes, muscular fibres, division into head and trunk. Thus far I saw distinctly; but Ehrenberg goes further; he gives to certain white striæ which are seen traversing the body of the animal, in different directions, but for the most transversely, the

denomination of bloodvessels or nerves. These striæ I saw distinctly, but whether they are either vessels or nerves, I cannot tell. The motions of the animals are rapid and vigorous; and they are particularly remarkable for a large longitudinal muscle, extending nearly the whole length of the body, which enables them to bend their body into various contortions, and to alter its form in a very remarkable manner*."

14. *Flying of Man and Birds.*—M. Navier read to the Academy of Sciences of Paris, the report of a committee, to whom was referred the memoir of M. Chabrier, wherein is proposed a method of flying, and of directing one's flight in the air! The apparatus consists of huge wings; the cavities of which are filled with hydrogen gas, and which the flying man is to move with his arms. The report states the committee's opinion to be, not only that the apparatus proposed by M. Chabrier is incapable of effecting the object in view, but that every machine constructed upon the same principle must be equally ineffectual. To demonstrate this, M. Navier endeavours to calculate the muscular exertions made by birds in flying, in order to compare it with what man is capable of. According to his calculations, a bird, to sustain itself in the air merely, without ascending or descending, employs in a second a quantity of action equal to that which would be necessary to raise his own weight to a height of 26 feet 3 inches; but if this bird desired to move horizontally with great speed, at the rate, for example, of 49 feet 2 inches in a second, which is often the case with birds that migrate, in their annual journeys, the quantity of action which it would have to expend in a second, would be equal to that which would be required to raise its own weight to the height of 1,280 feet, or thereabouts. Thus, in this case, it would employ a force nearly fifty times greater than it required merely to sustain itself in the air. It is therefore evident, that, in order to support itself on wing, a bird must be less sensible of fatigue than a man in supporting himself on his legs, if we have respect to the quantity of fatigue which the one and the other are capable of enduring. It is

* We have before us a more detailed account of Ehrenberg's discoveries, sent from Hamburgh, but too late for insertion in the present number of the Journal.

calculated that a man who is employed 8 hours a-day in turning a crane or wheel, raises at an average rate, in every second of time, a weight equal to 15 pounds troy, $39\frac{1}{2}$ inches high. Supposing that the weight be 175 lb. troy, the same quantity of action is capable of raising his own weight to a height of about 33 inches; so that, *cæteris paribus*, it is not the ninety-second part of that which is exerted by the bird to sustain itself in the air. If the man was capable of expending, in a space of time as short as he pleased, the quantity of action which he exerts ordinarily in the course of 8 hours, it appears that he might sustain himself in the air, each day, for the space of 5 minutes.

BOTANY, HORTICULTURE, &c.

15. *Erica mediterranea found native in Ireland.*—Mr James Townsend Mackay, curator of the College Botanic Garden at Dublin, having made a botanical excursion to the mountainous district of Cunnemara, during the past autumn, was fortunate enough to find Erica mediterranea "growing in prodigious abundance." This is the most important addition which has of late years been made to the Irish Flora. The plant has long been cultivated in the gardens of the curious; it withstands our Scottish winters in the open border, with difficulty, and only in sheltered situations, or near the sea-shore. It was regarded as being indigenous only to the countries bordering on the Mediterranean, and to Portugal; and certainly British botanists little expected to be able to claim it as a native of the sister island.

16. *Hybrid Azaleas.*—Mr Gowan at Highclere, the seat of the Earl of Caernarvon, has of late years raised many new sorts of American azaleas, by means of cross impregnation, chiefly between the high-coloured and late-flowering varieties. For mother plants, the different fine varieties of *A. coccinea*, were selected, major, minor, and rubescens, the anthers of which very seldom produce pollen. The two former were dusted for several successive mornings with the pollen of a late-flowering *A. pontica*. Many pods swelled, and produced perfect seed. The pods were gathered at the approach of winter, kept in a drawer for some weeks, and sown in the beginning of January. Of these about 400 seedlings were raised. The rubescens was impregnated with the pollen of *A. calendulacea*, or Lee's *triumphans*,

and about 100 seedlings were raised. Of the first-mentioned 400 seedlings, three-fourths closely resembled the male parent, *A. pontica*, in foliage, inflorescence, and general habit. Some were very beautiful, and highly fragrant. The remaining fourth part resembled the female parent in habit, but the foliage was rather on a larger scale. The colours of the blossoms were very rich, various tints of crimson, vivid pink or scarlet; and most of these will form beautiful acquisitions to our shrubbery borders.

17. *Preservation of Fruit-Trees from Hares.*—According to M. Bas, young fruit-trees may be preserved from the bites of hares, by rubbing them with fat, and especially hogs-lard. Apple and pear trees thus protected, give no signs of the attacks of these animals, though their feet-marks were abundant in the snow beneath them.—*Bull. Univ.* D. xiv. 381.

18. *Cure of Wounds in Elm-Trees.*—Those elms which have running places or ulcers, may be cured in the following manner. Each wound is to have a hole bored in it with an auger, and then a tube, penetrating an inch or less, is to be fixed in each. Healthy trees, which are thus pierced, give no fluid; but those which are unhealthy yield fluid, which increases in abundance with the serenity of the sky, and exposure to the south. Stormy and windy weather interrupts the effect. It has been remarked, that in from 24 to 48 hours the running stops; the place dries up; and is cured.—*Journal des Forets*, 1829.

19. *Preservation of Frozen Potatoes.*—In time of frost, the only precaution necessary is to retain the potatoes in a perfectly dark place for some days after the thaw has commenced. In America, where they are sometimes frozen as hard as stones, they rot if thawed in open day; but if thawed in darkness they do not rot, and lose very little of their natural odour and properties.—*Recueil Indust.* xiv. 81.

20. *Precautions in the planting of Potatoes.*—It would appear from experiments made in Holland, that when potatoes are planted, the germs of which are developed, as happens occasionally in late operations, or rather after mild winters, the produce differs in quantity by more than a third to what it

would be if potatoes which had not advanced had been used; and farther, that besides this diminished product, the quality is also very inferior.

GEOGRAPHY.

21. *Notice Regarding Lost Greenland.*—The Indicateur of Calais has the following:—We learn from Copenhagen, that an expedition which sailed from that port in May last, succeeded in reaching the eastern coast of Greenland, where some Norwegian colonists settled eight centuries ago, and to which all access had since been prevented by the ice. The expedition found there the descendants of the primitive colonists, who still profess Christianity. Their language is that of the Norwegians of the tenth century.

22. *Major Rennell's Chart of the Atlantic.*—We understand, from the editor of the lately published edition of "The Geographical System of Herodotus," there are preparing for press, from the manuscript of the late Major Rennell, a memoir on the general currents of the Atlantic ocean, accompanied by a series of charts, shewing their force and direction; and also a work on the ancient and modern geography of certain parts of Asia, with twelve maps.

23. *Intelligence of Captain Ross, R.N.*—Two accounts of the progress of Captain Ross's exploratory voyage have reached us. We give them as communicated to us. According to the one account, Captain Ross was met with in Baffin's Bay in August 1829, where, having suffered damage during hard weather, he fortunately was enabled, from the wreck of a Greenland ship, to refit. He afterwards steered northward, and has not since been heard of. The other account represents our adventurous commander and his brave crew as having been forced back to Lively Bay, in Baffin's Bay, where they spent last winter.

STATISTICS.

24. *Commerce of Great Britain.*—At a time when the commercial distress of this country is so great, and the utmost anxiety is everywhere shewn for effecting its relief, it will be inte-

resting to know the relation in which the various countries of the world stand to us with respect to the value and importance of the commerce which we carry on with them. The following table, for the year from January 1828 to January 1829, and derived from an official return laid before Parliament, will shew the state and value of our commerce with all countries, the first column of which exhibits the value of Imports for one year; and the second, the value of Exports. If we are to judge of the relative value or importance of the commerce of countries by the quantity of commodities with which they supply us, we shall find this shown in the first column of the table. But if we are to judge of the value of their commerce by the quantity of our native or colonial produce which they consume, this we shall find indicated in the second column.

Countries in the order of the Value of the Imports from them into Great Britain.	
1. British West Indies,	L. 8,908,672
2. East Indies and China,	8,348,767
3. United States of America,	5,820,581
4. Russia,	3,442,653
5. France,	3,159,307
6. United Netherlands,	1,978,110
7. Germany,	1,669,365
8. Brazil,	1,488,271
9. Africa, comprehending Egypt, Ports in the Mediterranean, Cape of Good Hope, Mauritius, &c.	1,175,813
10. Italy,	1,064,946
11. Prussia,	1,027,368
12. Spain and the Canaries,	978,612
13. British Northern Colonies of America,	838,991
14. Turkey and Continental Greece,	731,943
15. Portugal, Azores, and Madeira,	584,818
16. South American Republics,	535,085
17. The Whale-Fisheries,	428,591
18. Denmark,	371,929
19. Isles—Guernsey, Jersey, Alderney, and Man,	316,515
20. Foreign West Indies,	182,011
21. Sweden,	146,181
22. Ionian Islands,	143,592
23. New South Wales, &c.	84,812
24. Norway,	62,897
25. Gibraltar,	29,768
26. Malta,	16,329
27. Morea and Greek Islands,	260
Total Imports,	L. 43,536,187

Countries in the order of the Value of the Exports to them from Great Britain.	
1. Germany,	L. 9,467,093
2. United States of America,	6,843,727
3. East Indies and China,	6,388,330
4. Brazil,	6,155,721
5. United Netherlands,	4,956,116
6. Italy.	4,642,331
7. British West Indies,	4,049,856
8. South American Republics,	3,287,212
9. Russia.	2,753,887
10. British Northern Colonies of America,	2,206,914
11. Gibraltar,	2,078,693
12. Portugal, Azores, and Madeira,	1,764,033
13. Foreign West Indies,	1,450,562
14. Africa, comprehending Egypt. Ports in the Mediterranean, Cape of Good Hope, Mauritius, &c.	1,148,828
15. Prussia,	705,815
16. France,	643,308
17. Malta,	624,351
18. Spain and the Canaries,	613,615
19. New South Wales, &c.	611,500
20. Turkey and Continental Greece.	525,148
21. Isles—Guernsey, Jersey, Alderney, and Man,	440,828
22. Denmark,	267,599
23. Norway.	131,[illegible]65
24. Sweden,	129,611
25. Ionian Islands,	59,520
26. The Whale-Fisheries.	1,694
27. Morea and Greek Islands,	425
Total Exports,	L. 61,948,382

The sums are given according to the official valuation.

25. *Cholera Morbus.*—There was read at a late meeting of the French Institute, an interesting paper on the epidemic cholera at present raging in Russia. The author said that its progress can be traced from India through Persia; that the majority of those attacked were carried off within twenty-four hours; that

its propagation was entirely checked by intense cold, ceasing each year about the 15th of October, and breaking out again in the month of April. Humboldt, who made some observations on the paper, said that he was of opinion it was not imported into Europe by caravans, which are all subjected to a strict quarantine; and that the Russian army brought it back with them from Persia; and that its extension into southern Europe is very probable from the movements of large bodies of men to the western frontier of the Russian empire. To those interested in the nature of this terrible disease, we recommend, as the best treatise on the subject, that published by Dr Alexander Turnbull Christie.

ARTS.

26. *Size for Illuminators, Artists, &c.*—Four ounces of Flanders glue, and four ounces of white soap, are to be dissolved on the fire in a pint of water, two ounces of powdered alum added, the whole stirred and left to cool. It is to be spread cold with a sponge or pencil on the paper to be prepared, and is much used by those who have to colour unsized paper, as artists, topographers, &c.—*Bull. Univ.*

27. *Manufacture of Charcoal.*—A new process, recommended in the Journal des Forêts, for this purpose, is to fill all the interstices in the heap of wood to be charred, with powdered charcoal.

28. *Potash obtained commercially from Felspar.*—According to M. Fuchs, this important alkali may be extracted from minerals containing it, by the following method:—They are to be calcined with lime, then left some time in contact with water, and the liquor filtered and evaporated. M. Fuchs says, he has thus obtained from nineteen to twenty parts of potash from felspar, and from fifteen to sixteen from mica, per cent.—*Brand's Journal*, No. 1. New Series.

29. *Improvements in Printing*—It is well known that of late years a vast additional power has been given to the art of letter-press printing, by means of machinery. For speed, the newly-invented printing machines, when compared with the manual presses, are to printing what the power-loom is to weaving; and, accordingly, they are of great utility in all establishments

where newspapers and other periodical works having a large circulation are printed, and of course where the greatest number of impressions is required in the shortest possible time. Although the machines have been very much simplified since their first introduction, and much neater work is now accomplished with them than at first, yet they are still so expensive, and the manual presses so superior to them for the purposes of fine printing and general economy in the case of small impressions, that it is doubtful if the present kind of machines will ever come into general use. In confirmation of this opinion, it may just be stated, that long as these machines have been used in London, only two offices in Edinburgh have as yet obtained them, and we are not aware of there being a single machine elsewhere in Scotland. The machines, however, possess in their inking apparatus, one decided advantage over the common presses, for by it the ink is applied to the types with the utmost regularity and equality; while, at the common press, it is laid on in greater or less quantity, and with more or less regularity, according to the care or judgment of the pressman. Hence it frequently happens, in the latter case, that no two sheets, nor even both sides of the same sheet, are perfectly uniform in colour, though printed at the same press, and at all events seldom or never if printed at different presses.—In printing each sheet at the old press, two men are employed, the one for applying the ink, and the other for laying on the paper; and within the last 25 years a subsequent process of pressing or smoothing the printed sheets has been introduced, likewise requiring the labour of other two individuals. This last operation is performed by placing a printed sheet and a thin glazed pasteboard alternately above each other, till a sufficient number be obtained for filling a large screw-press or hydraulic-press. This being done, a very powerful pressure is applied, and the whole then allowed to stand consolidated for some hours, by which means the printed surface is completely flattened, and a glaze at the same time imparted to the paper. A book is thus much improved in appearance, but it is at a great additional expense to the printer, and for which he receives no extra remuneration. It would therefore be of no slight advantage to him could the labour of printing and pressing be diminished, and the inequality of inking at the press remedied; and it is conceived that both of these objects may be accomplished by the following or some similar means, to which the attention of engineers or of others acquainted with the subject is requested. 1*st*, As to the inking apparatus, that attached to the machines of Messrs Cowper and Applegath, might be placed immediately behind the tympans of the Stanhope or Columbian presses, and be worked by steam-power as at present. Were the tympans and carriage of the press in separate pieces, but made so as exactly to fit into each other, the carriage might, after each impression, be taken from the hand, upon reaching a certain point, by the inking apparatus, and, upon the types being rolled, returned to the same point. In the interim the pressman could be laying on and off his sheets, and by the time he had done so, the form would be again stationed at his hand, and ready for his taking another impression. It is obvious that the great difficulty to be overcome here will be the construction of the machinery for receiving and returning the carriage, and making the carriage so nicely to fit the frame-work of the tympans as to preserve *register*, as it is called; but, after the ingenious contrivance of Mr Napier in his machine for receiving and giving off the paper, there can be little doubt of these difficulties being soon obviated. In this way the great desideratum of securing an equality of colour would be supplied; and the expense of an apparatus for each press, with an engine-power for the whole, would be compensated, by only one half of the men being required. 2*d*, We have lately seen a cylindrical machine by Mr A. Moir of Glasgow, used for pressing and glazing white paper, and, although this machine, in its present state, is not altogether suited for the pressing of printed sheets of books, yet it may also be easily adapted to this purpose. The labour of turning it, however, is perhaps such as to prevent its adoption, unless where steam-power is at hand; but, were every printing-office supplied with this power, the cylindrical pressing machine would probably soon supersede the tedious operation and expense of the glazed boards and hydraulic press.—It will thus be perceived that the object sought to be attained is a still farther combination of manual labour and mechanical power; and could the above, or similar suggestions, be carried into effect, another great step would undoubtedly be gained in the art of printing.

NEW PUBLICATIONS.

1. Edinburgh Cabinet Library.—*Narrative of Discovery and Adventure in the Polar Regions and Seas.* Vol. I. *Narrative of Discovery and Adventure in Africa.* Vol. II. Published by Oliver & Boyd. 1830.

This we consider one of the best, and certainly the most elegantly got up, and the cheapest too, of the series of similar works at present in progress of publication in this country, on the Continent of Europe, and in the New World. The narrative is written with spirit and in good taste, by Mr Hugh Murray; the scientific department, by Professors Jameson and Leslie, and Mr James Wilson. Professor Leslie's estimate of the climate of the Arctic Regions is interesting; Professor Jameson's memoirs contain the first connected views hitherto published of the descriptive and speculative geology of the Arctic Regions, and of central and southern Africa; and Mr Wilson, in his zoological sketch, makes us agreeably acquainted with the more remarkable animals of the African Continent.

2. *Wilson's American Ornithology.*

Of this very delightful and fascinating book, an edition, under the superintendence of the Regius Professor of Natural History of our University, is in progress of publication for "Constable's Miscellany *." The plates which accompany the expensive original work will not be engraved for the Edinburgh edition, Professor Jameson being of opinion that the publication of these would so much increase its price, as to prevent its becoming a household book throughout the country; which, we doubt not, will be the case in its present form. "*Illustrations of Wilson's Ornithology*" are announced; but with these, neither Professor Jameson nor the proprietors of Constable's Miscellany have any connexion.

* It may interest our readers to know that the present system of popular and cheap works on science and literature, originated with the late Archibald Constable, Esq. The scheme was considered absurd by all his friends; but he appears to have known the public taste better than they; for Constable's Miscellany, an excellent work, has served, in some degree, as a general model for the popular works now publishing by all the great booksellers not only in Britain, but also in France, Germany, and Italy.

3. *Observations on Fossil Vegetables, accompanied by Representations of their Internal Structure, as seen through the Microscope.* By H. WITHAM, Esq. M.W.S., F.G.S. &c. 4to. Blackwood, Edinburgh.

THE geological public will feel indebted to our active and intelligent friend for this interesting and handsome volume. It is ornamented and illustrated with six neatly drawn, and well engraved, magnified representations of fossil and of recent woods, in which the structures are more correctly exhibited than is generally the case in similar works. The method of shewing the fossil structures, by cutting the woods into thin slices, and examining them by the microscope, is adopted; and although of late years less employed than it ought to have been, will now, we trust, from the interesting displays of internal arrangement which it displays, be more generally followed. The geological details in regard to the distribution and kinds of fossil wood, are also deserving the attention of naturalists.

4. *The Aberdeen, Dundee, Leith, and London Tide Tables for the year* 1831. By GEORGE INNES, Astronomical Calculator, Aberdeen.

WE have carefully examined this very useful annual, and find it, as heretofore, remarkable for precision and accuracy. It is the best work of the kind with which we are acquainted.

List of Patents granted in England from 27th February to 14th September 1830.

1830.

Feb. 27. To R. W. SIEVIER, London, for "certain improvements in the construction of rudders in navigating vessels."

To S. THOMPSON, Great Yarmouth, "for certain improvements in piano-fortes."

To P. C. De la GARDE, Exeter, for "certain improvements in apparatus for fidding and unfidding masts, and in masting and rigging vessels."

To W. HOWARD, Surrey, for "certain improvements in the construction of wheels for carriages."

To T. PROSSER, Worcester, for "for certain improvements in the construction of window-sashes."

Feb. 27. To T. R. GUPPY, Bristol, for "a new apparatus for granulating sugar."

To R. STEVENSON, Stafford, potter, for "improvements in machinery for making bricks, tiles, and other articles."

To J. RAMSAY and A. RAMSAY, and M. ORR, Greenock, for "an improvement in the manufacture of canvas and sail-cloth for the making of sails."

Mar. 20. To G. SCOTT, London, for "certain improvements on, or additions to, windlasses and relative machinery applicable to naval purposes."

To J. A. FULTON LAWRENCE, London, for "improvement in the preparation of pepper."

To W. E. COCHRANE, Middlesex, for "an improvment or improvements on his patent cooking apparatus."

To B. ROTCH, Furnival's, Middlesex, barrister-at-law, for improved guards, or protections of horses' legs and feet, under certain circumstances."

30. To J. RAWE, jun., Middlesex, and J. BOUSE, of the same place, for "certain improvments in steam-boilers, and of quickening the draft for furnaces connected with the same."

To W. AITKEN, Carron Vale, Scotland, for "certain improvements in the keeping or preserving ale, beer, and other fermented liquors."

31. To D. T. SHEARS, Southwark, Surrey, for certain additions to, and improvements in, the apparatus used in distilling, and also in the process of distilling and rectifying."

April 5. To T. J. COLLIER, civil engineer, and H. PINKUS, London, for "an improved method and apparatus for generating gas for illumination."

13. To T. W. A. SUMMERS, Middlesex, engineer, and N. OGLE of Mill-brook, Hampshire, Esq. for "certain improvements in the construction of steam-engines and other boilers or generators, applicable to propelling vessels, locomotive carriages, and other purposes."

24. To J. PERRY, bookseller, London, for an improvement or improvements in or on pens."

To J. M. INNES, North Britain, for "the manufacture or preparation of certain substances which he denominates the British Tapioca, and the cakes and flour to be made from."

To Commander S. BROWN, London, for "certain improvements in making or manufacturing bolts and chains."

To T. J. COCHAUX, London, for "an apparatus calculated to prevent, or render less frequent, the explosion of boilers in generating steam."

To P. DESCROIZILLES, London, for certain improvements in apparatus for economizing fuel in heating water and air, applicable to various purposes."

To Lieutenant T. COOK, Blackheath Road, Kent, for "certain im provements in the construction and fitting up of boats of various descriptions."

April 28. To J. Wilks, Surrey, for "an improvment in a part or parts of the apparatus for making paper by machinery."

To T. Petherick, Penfullick, in the parish of Tywardreath, Cornwall, for "machinery for separating copper, lead, and other ores from earthy and other substances with which they are and may be mixed, and which is more particularly intended to supersede the operation now practised or used for that purpose, commonly called Jigging.

May 4. To J. Walker, Middlesex, for "an improved cock for fluids."

8. To H. R. S. Devenoye, Middlesex, for "certain improvements in machinery for making bricks, communicated by a foreigner."

24. To M. Busk, printfield near Bonhill, by Dunbarton, North Britain, calico-printer, for "certain improvements in machinery or apparatus for printing calicoes and other fabrics."

June 3. To J. H. Bass, Middlesex, for "certain improvements in machinery for cutting corks and bungs."

8. To J. Levers, New Radford Works, near the town of Nottingham, for "certain improvements in machinery for making lace, commonly called Bobin-net."

11. To Dr W. T. Haycraft, Greenwich, for "certain improvements in steam-engines."

To G. V. Palmer, Worcester, for "a machine to cut and excavate earth."

17. To T. Brunion, and T. J. Fuller, Middlesex, for "an improved mechanical power, applicable to machinery of different descriptions."

29. To R. Hicks, surgeon, London, for "an economical apparatus or machine to be applied in the process of baking, for the purpose of saving materials."

To Dr E. Turner, Middlesex, and W. Shand, Esq. of the Burn, in Kincardineshire, for "a new method of purifying and whitening sugar, or other saccharine matter."

To T. M. Poole, London, for "certain improvements in the apparatus used for certain processes of extracting molasses or syrup from sugar."

To S. Parker, London, bronzist, for "certain improvements in producing the mechanical power from chemical agents, partly communicated by a foreigner."

To S. Parker, London, bronzist, for "an improved lamp, partly communicated by a foreigner."

July 1. To R. Roberts, Manchester, for "certain improvements in spinning cotton or other fibrous substances."

To J. Halive, Chell-house, Staffordshire, for "certain improvements in the construction of, and machinery for, locomotive ploughs, harrows, and other machines and carriages."

To J. H. Sadler, London, for "certain improvements in looms."

July 6. To M. Uzielli, London, for "improvements in the preparation of certain metallic substances, and the application thereof to the sheathing of ships and other purposes."

To Lieutenant J. Surman, Middlesex, for "certain improvements on bits for horses and other animals."

To W. W. Toxford, Boston, Lincolnshire, miller, for "machine or apparatus for cleaning or purifying wheat, grain, or other substances."

19. To Edward Cowper, and Eben. Cowper, Westminster, engineers, for "certain improvements in printing machines."

To J. Rawe junior, and J. Boase, of Middlesex, for "certain improvements in steam carriages and in boilers, and a method of producing increase of draught."

To Dr J. Bulkeley, Middlesex, for "certain improvements in propelling vessels, which improvements are also applicable to other purposes."

To W. Taylor, Wednesbury, Staffordshire, engineer, for "certain improvements on boilers, and apparatus connected therewith, applicable to steam-engines and other purposes."

To E. Riley, London, brewer, for certain improvements in the process and apparatus for fermenting malt and other liquors."

22. To G. Oldland, Hilsely, in the parish of Hawkesbury, Gloucestershire, clothworker, for "certain improvements in the machinery or apparatus for shearing and dressing woollen cloths and other fabrics."

24. To J. Ericsson, Middlesex, engineer, for "an improved engine for communicating power for mechanical purposes."

To A. Garnet, Esq. Demerara, for "certain improvements in manufacturing sugar."

To S. Roberts, Park Grange, near Sheffield, silver-plater, for "certain improvements in plating or coating of copper or brass, or mixture of the same, with other metals or materials, or with two metals or substances upon each other; as also a method of making such kind of articles or utensils with the said metals, when so plated, as have hitherto been made either of silver, or of copper or brass, or a mixture of copper and brass, plated or coated with silver solely."

To R. Ibotson, Poyle, Middlesex, paper-manufacturer, for "an improvement in the method or apparatus for separating the knots from paper stuff or pulp used in the manufacture of paper."

29. To J. Ruthven, Edinburgh, engineer and manufacturer, for "an improvement in machinery for the navigating of vessels and propelling of carriages."

To J. Down, Leicester, surgeon, for "certain improvements in making gas for illumination, and in the apparatus for the same."

To J. Street, Esq. Clifton, Gloucestershire, for "a new mode of obtaining a rotatory motion by water, steam, or gas, or other vapour; also to the giving blast to furnaces, forges, and other purposes, where a constant blast is required."

July 29. To W. Dobree, Fulham, Middlesex, for "an independent safety-boat of novel construction."

To W. Lane, Stockport, for "certain improvements in machines which are commonly known among cotton-spinners by the names of the roving-frames, or otherwise called cove-frames, or bobbin-and-fly-frames, or jack-frames."

Aug. 5. To T. Hancock, Middlesex, for "improvements in the manufacture of certain articles of dress or wearing apparel, fancy ornaments and figures; and in the method of rendering certain manufactures and substances, in a degree or entirely, impervious to air and water; and of protecting certain manufactures and substances from being injured by air, water, or moisture."

To W. Mallet, Dublin, iron-manufacturer, for "certain improvements in making or constructing certain descriptions of wheel-barrows."

To J. Pearse, Tavistock, Devon, ironmonger, for "an improved method of making and constructing wheels, and in the application thereof to carriages."

To C. Shiels, Liverpool, for certain improvements in the process of preparing and cleansing rice, communicated by a foreigner."

To O. Coffrey, Dock Distillery, Dublin, distiller, for "certain improvements in the machinery used in the process of brewing and distilling."

To M. Robinson, Westminster, for "certain improvements in the process of making and purifying sugars; communicated by a person residing abroad."

To R. Clough, Liverpool, for "an improved supporting block to be used in graving docks, and for other purposes."

To Sir C. W. Dance, Hertfordshire, for "certain improvements in packing and transporting goods."

7. To S. Smith, London, for "a new nipple or touch-hole to be applied to fire-arms, for the purpose of firing the same by percussion; and a new cap or primer for containing the priming, by which such fire-arms are to be fired."

10. To W. Palmer, London, for "improvements in making candles."

To J. Lawrence, Birmingham, and W. Rudder, Edge, Gloucestershire, for an improvement in saddles and girths, by an apparatus affixed to either of them.

12. To T. Ford, Canonbury Square, Middlesex, for "certain improvements in the medicine for the cure of coughs, colds, asthmas, and consumptions, known by the name of Ford's Balsam of Horehound."

13. To J. Knowles, Farnham, Surrey, hop-planter, for "a certain instrument or machine for drawing up hop poles out of the ground previous to picking the hops; and which, by drawing the poles perpendicularly, will greatly save them, as well as prevent the

hops from being bruised, called a "hop-pole drawer by lever and fulcrum.'"

Aug. 18. To M. Towgood, Dartford, Kent, and L. Smith, stationer, for an improved mode of applying size to paper."

To Major-General J. Gubbins, Southampton, for "certain improvements in propelling and giving motion to machinery."

16. To S. R. Bakewell, Middlesex, for "certain improvements in machinery, apparatus, or implements to be used in the manufacture of bricks, tiles, and other articles to be formed or made of clay, or other plastic materials; part of which machinery is also applicable to other useful purposes."

24. To W. Mason, London, for "certain improvements in axletrees, and also the boxes applicable thereto."

31. To T. Barrat, London, paper-maker, for "certain improvements in machinery for making paper."

To A. Applegath, Crayford, Kent, printer, for certain improvements in printing-machines."

To W. Losh, Esq. of Benton-house, Northumberland, for "certain improvements in the construction of wheels for carriages to be used on railways."

To E. Budding, parish of Stroud, Gloucestershire, for "a new combination and application of machinery for the purpose of cropping or shearing the vegetable surface of lawns, grass-plats, and pleasure-grounds, constituting a machine which may be used with advantage, instead of a scythe for that purpose."

To J. Hanson, Huddersfield, for "certain improvements on locomotive carriages."

To E. Clayton, Nottingham, for "an improved mode of manufacturing dough or paste for the purpose of baking into bread."

Sept. 7. To T. Thacher, Birmingham, for "an elastic self-adapting saddle."

To P. Williams, Holywell, Flintshire, surgeon, for "an apparatus or contrivance for preventing accidents in carriages, gigs, and other vehicles, instantly and effectually liberating horses or other animals from the same, when in danger or otherwise; and for locking and securing the wheels thereof, in case of danger, emergency, or otherwise."

To C. B. Vignoles and J. Ericsson, London, for "certain additions to the engines commonly called locomotive engines."

To W. Cook, London, for "certain improvements on cocks for supplying kitchen ranges and cooking apparatus with water, and for other purposes, to be called fountain cocks."

To H. G. Pearce, Liverpool, R. Gardner, and J. Gardner, of the same place, merchants, for "an improved fid."

13. To J. Chadley, London, for "certain improvements in making or forming bricks, tiles, and chimney bars, applicable to the building or erecting the flues of chimneys."

14. To S. Smith, London, builder, for "certain improvements in chimneys for dwelling houses, and other buildings."

List of Patents granted in Scotland from 16*th September to* 30*th November* 1830.

1830.

Sept. 16. To William Dobree of Fulham, in the county of Middlesex, Gent., for an invention of "an independent safety boat of novel construction."

To William Shand of the Burn, in the county of Kincardine, Scotland, for an invention of "certain improvements in distillation and evaporation."

To Charles Blacker Vignoles of Furnival's Inn, London, and John Ericsson of Brook Street, Fitzroy Square, in county of Middlesex, civil engineers, for an invention of "certain additions to the engines commonly called locomotive engines."

To Joseph Cochaux of Fenchurch Street, in the city of London, merchant, for "an invention" (communicated to him by a foreigner residing abroad) "of an apparatus calculated to prevent or render less frequent the explosion of boilers in generating steam."

17. To Alexander Craig of Ann Street, St Bernard's, in parish of St Cuthbert's, Midlothian, for an invention of "certain improvements in machines or machinery, for cutting timber into veneers or other useful forms."

To Marmaduke Robinson junior of Great George Street, Westminister, Navy agent, for an invention communicated by a foreigner residing abroad, of "certain improvements in the process of making and purifying sugars."

22. To Henry George Pearce of Liverpool, master mariner, Richard Gardner, and Joseph Gardner, of the same place, merchants, for an invention of "an improved fid."

To William Losh of Benton House, county of Northumberland, for an invention of "certain improvements in the construction of wheels for carriages to be used on railways."

Oct. 16. To Timothy Mason, 56. Great Portland Street, Middlesex, brushmaker, for an invention of "an improvement in the manufacture of painting-brushes, and other brushes applicable to various purposes."

To William Augustus Archbold of Vere Street, Cavendish Square, Middlesex, lieutenant in the Royal Navy, for an invention of "an improvement in the preparing or making of certain sugars."

21. To Æneas Coffey of the Dock Distillery, Dublin, distiller, for an invention of "certain improvements in the apparatus or machinery used in the processes of brewing and distilling."

To Michael Donovan of the city of Dublin, for an invention of "an improved method of lighting places with gas."

Nov. 11. To Robert Hicks of Conduit Street, parish of St George, Hanover Square, Middlesex, surgeon, for an invention of "an economical apparatus or machine to be applied in the process of baking, for the purpose of saving materials."

23. To John Heaton, William Heaton, George Heaton, and Reuben Heaton of Birmingham, in the county of Warwick, manufacturers and co-partners, for an invention of "certain machinery, and the application thereof to steam-engines, for the purpose of propelling and drawing carriages on turnpike roads and other roads and railways."

To Augustus Applegath of Crayford, in the county of Kent printer, for an invention of "certain improvements in printing machines."

To Samuel Clarke of South Down, Brixham, in the county of Devon, Gent., for an invention of "certain improvements in making or preparing saddle lining, saddle cloth, and girths, for keeping saddles in place on horses or other animals of burden."

To Joseph Gibbs of Crayford, in the county of Kent, engineer, for an invention of "improvements in evaporating fluids, applicable to various purposes."

To Matthew Bush of Dalmarnock printfield, in the neighbourhood of Dunbarton, for an invention of "certain improvements in machinery or apparatus for printing calicoes and other fabrics."

To Thomas Bramley, Gent., and Robert Parker, lieutenant Royal Navy, both of Moulsey Priory, in the county of Surrey, for an invention of "certain improvements on locomotive and other carriages or machines applicable to rail and other roads which improvements or part or parts thereof are also applicable to moving bodies on water, and working other machinery."

30. To James Chesterman of Sheffield, in the county of York, mechanic, for an invention of "certain improvements on machines or apparatus for measuring land and other purposes."

TO CORRESPONDENTS.

The Editor has to apologise to correspondents for the non-appearance of papers sent for insertion. They will appear in next Number of Journal.

THE

EDINBURGH NEW PHILOSOPHICAL JOURNAL.

On the Diluvial Theory, and on the Origin of the Valleys of Auvergne. By C. DAUBENY, M. D., F. R. S., Professor of Chemistry in the University of Oxford, &c. &c. In a Letter to Professor JAMESON.

DEAR SIR,

IT is now more than ten years since I published in your Journal a brief and general account of the volcanos of Auvergne, which, in spite of its many imperfections, of which no one can be more sensible than its author, will perhaps be allowed the humble merit of having contributed to direct the attention of British naturalists to this interesting field of continental geology.

Since the appearance of my memoir, Auvergne has been visited by Mr Scrope, Professor Buckland, Messrs Lyell and Murchison, and sundry other scientific travellers; and through their collective exertions such a mass of information has been brought together, with reference to the phenomena therein exhibited, that there is probably no volcanic district in the world now more fully explored, nor perhaps any country out of Great Britain with the geological relations of which we are more familiar.

You will easily believe, that I have been far more gratified at seeing so many distinguished naturalists *following in my track*, than mortified at finding them sometimes arrive at conclusions different from my own; and that, under this feeling, I should be the more inclined, even where my confidence in my original views remained unshaken, to waive controversy, and wait with patience for the slow but sure judgment of the public, to pronounce upon the points at issue between us.

I have been induced, however, to depart from this my original purpose, chiefly in consequence of the perusal of my friend Mr Lyell's work, entitled, "Principles of Geology;" not from any ambition on my part to contend generally against the views he has put forth, but from an anxiety to explain myself more fully than I have hitherto had occasion to do on a question much agitated in his volume, I mean the causes to which the excavation of valleys is to be referred—seeing that the nomenclature, as well as to a certain degree the theoretical views I have adopted in my Description of Volcanos *, with reference to this subject, are those of writers to whom the author alluded to seems directly opposed.

Nevertheless, I am inclined to think that the discrepancy between his opinions and my own on this particular point, reduces itself almost to a question of degree; for I observe that in more than one passage of his work, the probability of extensive floods having from time to time occurred in consequence of the bursting of vast lakes, is distinctly admitted, and it can hardly be doubted, but that from such catastrophes would result effects of a similar nature to those commonly ascribed to that diluvial action so insisted on by geologists of a different school.

It is, however, no less true, that, in accounting for this class of phenomena, much greater stress is laid in his treatise on the long continued operation of causes of daily occurrence, than on the consequences of such occasional catastrophes, and that many might rise from its perusal under an impression, that geologists of the present day, who take a different view of such phenomena, still adhere to the doctrine maintained by their predecessors, who, to use Mr Lyell's words, supposed "that the monuments which they endeavoured to decipher relate to a period when the physical constitution of the earth differed entirely from the present, and that even after the creation of living beings there have been causes in action, distinct in kind or degree from those forming a part of the present economy of nature."

* A Description of Active and Extinct Volcanos. By Charles Daubeny, M.D. F.R.S. &c. &c. 8vo. London, 1826.

Such a notion, indeed, would be quite at variance with the general tenor of my work on Volcanos, the express object of which was to shew, that the same causes which produce volcanic phenomena at the present moment, operating at some former period on a greater scale, but always agreeably to the same system, have had an important share in preparing the earth's surface for the abode of the existing races of animals *.

It is, however, true, that certain writers, whose opinions I have quoted rather than adopted at the commencement of the work in question, embarrassed by the difficulties they encountered in their attempts to explain the phenomena alluded to by the operation of present agents, and perhaps not sufficiently considering the still greater objections to the supposition of a change having taken place in the course of nature, may have laid themselves open to Mr Lyell's criticisms, by adopting the opinions of earlier naturalists with respect to a want of conformity in the physical constitution of the earth during ancient and modern times.

Hence, in order to enable others to form a candid estimate of the comparative merits of the views of Mr Lyell with respect to the excavation of valleys, and those of the Diluvianists, it seems important that we should do away with the prejudice that would operate against the latter, from associating them with this hypothesis; and it may therefore be worth while to shew that no necessary connexion exists between the two, but that all the postulates of the diluvial theory may be resolved into the operation of known agents, acting according to laws at present recognised †.

It will doubtless be considered as so far favourable to this system, if it can be proved, that it supposes no other catastrophes or revolutions to have taken place, than such as would na-

* Similar, too, have been the conclusions to which I have since been led by my researches on the presence of iodine and bromine in the salt-springs of this country, as it appears from the results I have obtained, that the constituents of the earliest seas, such for instance as existed at the time of the transition formation, were precisely the same as those of the present day, and, consequently, that the laws of nature in this respect have continued from the first unchanged.—*See Phil. Trans. for* 1830.

† Having written the greater part of this letter whilst on the continent, I was not aware that Mr Conybeare had already entered a protest, in the Annals of Philosophy for October last, against the notion, that in the diluvial theory the operation of a different system of causes is necessarily implied.

turally arise, agreeably to existing laws, from events which we believe on independent grounds to have taken place, and which the very persons most opposed to aqueous inundations are often the foremost to contend for.

I do not here allude to the occasional bursting of lakes, which, as we have already seen, may in particular situations account for some of the phenomena under consideration; because it is impossible to imagine such local catastrophes to have occurred in all the spots where indications of diluvial action are supposed to present themselves; but I maintain, that there is a probability of floods having taken place, more considerable in point of extent, more generally diffused over the earth, and therefore more capable of modifying the character of its surface, than those supposed by Mr Lyell to have resulted from the local causes he has assigned.

The same sudden rise of an extensive body of water, which would in the present day be produced by the throwing up of a chain of hills, in the midst of the Mediterranean, might, as it appears to me, have resulted from such events as the elevation of the Alps, the Pyrenees, or the volcanic chain of the Andes, the two former of which we know to be surrounded by immense sedimentary deposits, which may have arisen from the aqueous inundations that were the immediate consequences of their rise.

It is indeed only necessary for such a supposition, that the catastrophe should have occurred in the vicinity of large lakes or seas, and that it should have been brought about in a short period of time; and the latter, although I am aware it is contrary to the opinion of Mr Lyell, is the doctrine, I believe, of most of the other supporters of the elevation theory, and especially of Monsieur Elie de Beaumont, whose recent conclusions, with regard to the successive rise of several chains of mountains in different parts of the globe, can hardly be embraced in their full extent, except by those who are willing to admit, as a consequence, the occurrence of several extensive, if not universal, deluges.

The doctrine in question has the further advantage of rendering the accounts of such catastrophes, which are handed down to us on the authority both of history and tradition, consistent with probability, instead of opposed to it; in harmony with scientific research, instead of involving, as Voltaire rashly asserted, a physical impossibility; and thus, if not directly confirming the Mosaic history on this particular point, removing at least those obstacles to its reception that might exist, if we considered the event related as out of the course of nature, and only to be explained by the instrumentality of causes unknown to us at present, and which had disappeared without leaving any traces of their existence behind them.

It is, however, far from my intention to excite a prejudice against any attempt that may be made to explain the phenomena in question on different principles, by insinuating the inconsistency of such other conclusions with the Mosaic records. Nothing, I conceive, can be more unfair than such a mode of attack, or more likely to do injury to the cause it professes to serve. But though a doctrine in science *may* be true, although involving conclusions that cannot be reconciled, at the time, to the statements of Scripture, it will be allowed to be somewhat more probable when in conformity to them; and, in the present instance, considering, as I should wish to do, the question in the same light as one in which the veracity of profane history alone was at stake *, we shall be inclined to regard it as a recommendation to the view taken, that it confirms and accounts for an event which has reached us through such a variety of distinct channels, that few probably would feel themselves justified in rejecting the fact of its occurrence, however much they may be disposed to differ as to its details.

It is not, however, my intention to controvert the opinions of Mr Lyell on this point, but only to show that more might be attributed to the effect of sudden catastrophes than he appears

* I make this concession, in order to prevent the possibility of my being accused of having mixed up a question of theology with one of science. The mode in which the deluge might have taken place, the causes which produced it, its universality, and other points of the same description, cannot, I admit, be decided by the words of Scripture, the writers of which describe merely appearances and effects, and need not be supposed to have been enlightened with respect to their physical causes. This, however, is quite foreign from the question, whether, in balancing the rival pretensions of two scientific theories, we should be justified in throwing out of the scale the evidence derived from a fact so circumstantially related in the earliest of known records, and confirmed, in the main, by the traditions of other nations?

disposed to do, without our imagining a change in the laws of nature; and that, in accounting, according to our principles, for the phenomena originating in the action of water, of some kind or other, which the globe exhibits, we are no more driven to resort to a distinct system of causes, than, in conceiving vast chains of hills to have been thrown up in former periods of the earth's history, we are obliged to call into play other than those volcanic forces which, on a less considerable scale, we observe at the present day in operation.

The principal difference, indeed, between these two opinions seems to be, that, whilst the one supposes the igneous and aqueous agents at work to be proceeding at all times at a gentle but uniform rate; the other, on the contrary, imagines periodical returns of violent action, with intervals of comparative tranquillity, in both, and thus accounts for the elevation of large tracts of land by the short but forcible operation of those agents, which, according to the former hypothesis, have occasioned both by an action that compensated for its inferior energy by its longer duration.

Neither of these explanations ought to be viewed as inconsistent with the actual course of nature; for it is evidently quite conceivable, that the same catastrophes, both of fire and water, which we infer from natural phenomena, and have acquired a knowledge of from history, may at some future period recur *. According to this view, the deluge recorded by Moses as instrumental in destroying the human race, may have been the

* Having appealed to Scripture as an historical document, my opponents may perhaps retort upon me the assurance given in Holy Writ, that mankind is never again to be destroyed by water, as inconsistent with the supposition of another deluge taking place at any future time. To this objection, however, it may be sufficient to reply, that, in order that the same consequences should result at present from such a catastrophe as followed from the Noachean Flood, it would be necessary that it should sweep simultaneously over the whole surface of the globe,—a circumstance which I am not prepared to admit with regard to any former deluge, and which I am therefore not obliged to assume in any of those which are to follow. With respect, indeed, to the universality of the Mosaic Deluge, since divines themselves are divided upon it, laymen may surely be allowed a certain latitude of opinion; and it has always appeared to me, that the phenomena to which geologists appeal in proof of the reality of the event alluded to, may be just as well explained by a number of partial though extensive floods, as a single universal one.

latest of several floods which have, at different times, inundated the surface of large portions of the globe, originating from the sudden elevation of some great chain of mountains; for, notwithstanding the moral purpose we are told it was intended to fulfil, there seems no greater reason for supposing it brought about by other than natural agents, than there is for imagining the volcano which destroyed the cities in the plain of Gomorrha, to have been governed by laws of a different kind from those which determine its eruptions in other instances.

If it be asked, What is the range of mountains to the elevation of which the deluge in question can be referred? we may reply, that the part of Asia which must be supposed to have been the principal scene of its ravages, is as yet too little explored to allow of our determining the point *.

Of this, however, at least we are certain, that the period extending from the formation of the chalk to the more recent tertiary deposites, was of all others with which we are acquainted most fruitful in volcanic operations. It was within this interval that the whole of the extinct volcanos in Europe began to burst forth, and from whence the origin of those which we consider now in action appears to date.

That extensive inundations should have occurred during this period is therefore not surprising, and that the Mosaic Deluge was one of many cases of the kind, is a fact which seems confirmed, not only by the universal occurrence of beds of gravel, but also by those enormous deposits of conglomerate and sand which are so common in many tertiary formations.

If it be objected, that we have no experience of volcanic operations giving rise to deluges in the present day, and therefore have no right to attribute to them such consequences in periods antecedent; we may reply, that the first elevation of a volcanic range of hills might be expected to occasion more formidable convulsions of nature than follow after a suitable vent has been

* Perhaps the memoir lately published by Humboldt, on the elevation of mountains and other evidences of volcanic action in central Asia, may throw some light upon this subject. It seems more reasonable at least to connect this event with the appearance of a chain of mountains in that quarter of the globe, than, as Elie de Beaumont seems inclined to do, with the elevation of the Andes.—*Annales des Sciences Natur.* tom. xix. p. 232.

established; and that in many instances one of the first effects of the igneous agency seems to have been the throwing up of a cone sometimes many thousand feet in height, and of proportionate diameter.

This latter notion, however, has been controverted by Mr Scrope, and after him by Mr Lyell, both of whom appear to regard every sort of volcanic mountain as occasioned merely by the accumulation of the products of many successive eruptions. Now, I must allow, that the latter geologist has succeeded in removing one of the strongest objections I had formerly entertained against the theory originally proposed by Mons. Necker, and adopted by himself and Mr Scrope, which arose from the difficulty of imagining the brim of a crater to continue throughout so uniformly level, as to allow the lava to flow at once over all its sides. This supposition he seems to have shewn not to be necessary, since the beds which constitute a volcanic cone, when carefully examined, do not appear to be continuous belts extending round the mountain*, but a sort of compensation existing between the matters ejected from the several sides of the crater, which produces on the great scale a fallacious appearance of regularity.

But whilst I admit the possibility of explaining in such a manner the origin of this description of cone, I am at a loss to extend the same hypothesis to mountains of *trachyte*, which, like the Puy de Dome, or some of the volcanos of the Andes, occur detached in the midst of a chain of differently constituted rocks, and appear to maintain in a great degree the figure which they must have possessed when first generated by volcanic action.

To me at least it seems, that every attempt that has been hitherto made to account for the formation of such hills without having recourse to Von Buch's hypothesis, is encumbered with much more formidable objections; and I could wish those who are sceptical on the subject, and are disposed to cavil at the unnecessary introduction (as they conceive) of a new principle, to suspend their decision until they have examined the five domitic hills in Auvergne, and considered in what other manner they

* I had overlooked a passage in p. 168 of Mons. Necker's Memoir, in which the same circumstance is stated.

would explain the regularity of their form, their perfectly detached and isolated position, and their occurring each in the midst of a sort of amphitheatre composed of volcanic rocks of a totally different description.

Diluvial action here will not assist us, for had the domitic hills alluded to been the fragments of a continuous stratum or coulée once extending along the line in which they occur, some vestiges of the rock in question would be found in the intervening spaces, as well as for some distance beyond the hills that are placed at either extremity of the range; neither would the craters of the surrounding rocks, which must in many cases be presumed to be of greater antiquity, have remained undestroyed by a current of water which acted with sufficient force and continuance to reduce the Puy de Dome to its present conical form.

The ordinary action of water is still more inadequate to the effect supposed, for the whole of the table-land on which these mountains repose, consists of volcanic matter of so porous a description, that scarcely a drop of water rests upon its surface, and nearly the whole which falls from the heavens sinks down into the soil, until it finds an exit in the Valley of Royat beneath, a little way from the city of Clermont.

The only other hypothesis is that of Mr Scrope *, who sup-

* Mons. Lecoq, the director of the museum at Clermont, who, from his general intelligence, no less than from his particular acquaintance with the geological structure of Auvergne, deserves to be listened to in a case of this kind, has published, in the "Annales Scientifiques de l'Auvergne," an account of these domitic cones, accompanied with a theory of their formation, differing in some respects from that of Von Buch, but at the same time totally opposed to the one which Mr Scrope has advocated. He argues that the appearances which he describes, imply the action of water as well as of fire; the first being indicated not only by the rolled fragments intermixed with the domite itself, but also by an alluvial deposit which covers it in many places, as, for instance, on the summit of the Great Cliersou; the latter by the crystals of glassy felspar, fer oligiste, &c., as well as by the position, form, &c. of the mountains themselves. To reconcile these two facts, he supposes the domite to have constituted a part of that great tufaceous deposit which is seen at Boulade, near Issoire, and which has doubtless been derived from the trachyte of Mont Dor. This, after having been spread on the sides of the latter chain by the operation of water, he imagines to have been in these points uplifted by the volcanic action which took place beneath it, to which cause must be attributed the crystals of glassy felspar, and the other indications of fire which the rock presents. A curious confirmation of this

poses a sort of tenacity or adhesiveness to belong to trachytic lava, which, together with its inferior specific gravity, would, in his opinion, exempt it from the laws which regulate the flowing of igneous products in general, and cause it to accumulate round the point from which it issued in concentric layers (of which by-the-by the rock never exhibits any traces) until it reached, at length, the height and dimensions which these cones are now found to possess, of which the Puy de Dome, the loftiest mountain in the department, may give us a suitable idea.

Unfortunately for this hypothesis, observation has furnished us with no difference between the manner in which trachytic and basaltic lavas flow when they issue from the earth. The current of Mount Olibano near Naples, which is composed of trachyte, has descended the external slope of the Solfatara, just in the same way as the most modern lavas from Vesuvius; and where, as sometimes happens, trachyte and basalt occur together, no difference has as yet been discovered in the thickness or extent of their beds, such as should imply any greater tendency in the one than in the other species of rock to accumulate round a central point, instead of obeying the laws of gravity.

It would he wonderful, indeed, if any such difference did

theory is, that no part of the rock in question contains any alkali, except the crystals of glassy felspar occasionally present; now, this may be reckoned as a natural effect of the continued action of water upon a substance of a felspathic nature, as we find at present exemplified in the case of the granites of Cornwall, and of other localities. Thus, he attributes to the modern volcanoes of Auvergne two sorts, or rather degrees, of action:—when their energy was sufficient to break through the trachytic tuff, craters would be formed, having their walls composed of the ejected materials, and this is the more usual case both here and elsewhere; but when the force was insufficient for this effect, it might simply upheave a portion of the tuff round a circumscribed area, and produce certain alterations in its internal structure, of which we have examples in the Puy de Dome, and other mountains of similar composition.

I had myself proposed a similar hypothesis, when I alluded in my work on Volcanos to the curvature of the beds exhibited on the coast of the Island of Procida, near Naples. (See page 179.)

Whatever objections may be raised against that part of Mons. Lecoq's theory which respects the material from which the domite was elaborated, I think it will be admitted, that the facts he has brought forward are perfectly irreconcilable with the notion, that it was derived from a mass of lava which congealed round the orifice that ejected it.

exist between the two; the specific gravity of trachyte, in general, whatever may be the case with regard to that particular modification called Domite, differs not very materially from that of some augitic lavas which chance to be deficient in magnetic iron; and its chemical composition holds out no greater prospect of any such distinction existing; neither is it very intelligible in what manner, supposing a sort of nucleus to be formed by the first portion of the lava, in the manner Mr Scrope represents, the succeeding ejections, of which the latest must have been sufficiently fluid to rise to the height of near 3000 feet above the level of the table-land, should so immediately have obtained a sufficient degree of adhesiveness, as to attach themselves merely to the external sides of the cone, without spreading further into the adjacent plain.

I need hardly say how much more difficult it would be to extend the hypothesis to such a case as Chimborazo. But after all, where is the advantage of resorting to so forced an explanation, in order to avoid supposing *that* with regard to volcanic mountains, which most geologists are now ready to admit with respect to others?

A Wernerian, who rejected volcanic agency altogether, and attributed all the different inclinations of rocks to subsidence, &c., might consistently enough object to the theory of craters of elevation, which Von Buch has proposed; but a vulcanist, who sees the proofs of the heaving up of rocks by the agency of elastic vapours in all the chains of mountains he visits, admits the very principle as a general truth, which he rejects in the particular case to which it is most applicable; for how can mountains be elevated without a void being occasioned underneath them? or why should that be considered absurd with respect to domite, which is probable in the case of granite?

What other effect, indeed, should we be disposed to attribute to volcanos, so long as we are all agreed in assigning to elastic vapours, coupled with the influence of an exalted temperature, the principal share in their production?

What more natural than to ascribe to such forces, either singly or combined, not only the fusion and ejection of the substances most contiguous to the focus of their action, but also the softening and heaving up of the rocks somewhat farther removed from it, and the rending and fracturing of such as were at a still greater distance? It seems clear, that as the slow conducting power of earthy bodies would prevent the more superficial strata from being affected by the heat kept up beneath them, so their bulk and unequal consistence would preserve them from the same degree of displacement which might be occasioned by a similar force, applied to a body of less considerable thickness, and of a more uniformly unyielding texture. Were it not that the shock caused by the extrication of elastic vapours in the interior of the earth is somewhat moderated by the nature of the materials on which it is exerted, the most trifling earthquake, instead of occasioning only a moderate degree of devastation, and sparing, in great measure, even the frail works of man, would throw into confusion the very rocks on which they stand, and reduce the whole country into a state of primitive chaos.

Owing, however, to the causes assigned, the strata in an uplifted chain of mountains, though occasionally fractured and displaced, still retain their distinctness, and are often free from any of the effects due to the direct application of heat; neither ought we to be surprised if, under similar circumstances, the beds of a volcanic mountain, though uplifted in the same manner, retain an equal degree of regularity in their arrangement.

There seems, therefore, no absurdity in attempting to apply Von Buch's theory to volcanic rocks, of whatever materials they may chance to be constituted. In the more ordinary case, indeed, where there is an alternation of beds of scoriæ and lava, we are at liberty, no doubt, to choose between this and the contrary hypothesis, according as the circumstances may appear most favourable to one or the other; but where the volcano in question is composed of a conical mass of trachyte or domite, elevated in the midst of dissimilar rocks, as we observe in the mountains alluded to in Auvergne, the absence of any other plausible theory to account for the phenomena appears to leave us no alternative.

The prejudice entertained against this theory in England, seems to me to have arisen in part from Humboldt's well-known comparison of Jorullo to a vast bladder, blown out by elastic vapours, a metaphor borrowed from Ovid, who applied it to the analogous case of the mountain Methone in Argolis, which tradition represented as having been heaved up in that manner.

I do not, however, imagine that, by the metaphor in question, anything more was meant to be conveyed than that the materials of which the mountains consisted had been heaved up whilst in a pasty condition, by elastic vapours, generated during the action of the volcano; or that any comparison was intended between the relative thickness of the external crust of the cone to a supposed internal cavity, and that of the membrane of the bladder to the air which distended it.

The very supposition of one regular vault existing within the mountain is neither a necessary nor even a probable one; for it is more conceivable that the cavity occupied by the vapours which heaved up these masses of rock should have been subsequently filled, either wholly or in part, by ejections of lava: but this need not alter our view of the manner in which the mountain acquired its conical form, or dispose us to reject an hypothesis, which furnishes us at least with the only plausible explanation that has yet been offered of the circumstances of the case.

The objection urged against this theory, which is built upon our want of experience of any such event as the elevation of a cone in the manner supposed, loses much of its force when we reflect, how few instances are recorded of new hills having been produced by volcanic agency within the memory of man; and how totally without examples we are of trachytic cones (to which the theory in question best applies), formed within this comparatively small fraction of the history of the globe. All the active volcanos, indeed, described by scientific travellers, except Jorullo, are known to have begun their eruptions before the existence of authentic records; for we cannot regard Vesuvius and the other ignigenous mountains in the neighbourhood of Naples, in any other light than as different vents of one great volcano, or doubt that a similar connexion must exist in other localities between the several craters of the same district.

Now, if we are willing to adopt the conclusions of the most distinguished naturalist who has hitherto studied the phenomena of Jorullo, conclusions, I may add, which remain unquestioned by any traveller who has since visited the spot, it will follow that the only case, which affords us an opportunity of putting our theory to the test, completely confirms it, the first volcanic operations in this place appearing to have caused an upheaving of the rocks within a given area.

I am, however, as I stated in my work on volcanos, more disposed to reason from the Puy de Dome to Jorullo, than to follow, as most others appear to have done, the opposite line of argument; granting, with Mr Scrope and Mr Lyell, that the facts which Humboldt has brought forward with respect to this mountain would be insufficient to establish the fact of its having been heaved up, if such a phenomenon be considered as entirely without precedent, but contending that, the occurrence of other events of the kind once admitted, there is no longer sufficient reason for disputing his conclusions in this particular case.

Leaving, therefore, the question as to Jorullo to be determined by the opinion we may form with respect to the origin of volcanic mountains in general, I think it may be fairly urged, without any risk of going beyond what our premises warrant, that the doctrine in question, even should it not have been confirmed by experience, is not contradictory to it; in which case, if it explains the phenomena exhibited by the cones of trachyte alluded to, we are surely at liberty to adopt it, notwithstanding the absence of any analogous phenomena observed at present, just as the occurrence of huge blocks of granite on the summits of the Jura, and in other situations to which they could not have been brought by rivers, justifies us in supposing an aqueous inundation to have taken place of an extent which we have no experience of in modern times.

Mr Lyell has, indeed, himself allowed, "that if a single cone could be discovered, composed entirely of marine or lacustrine strata, without a fragment of any igneous rock intermixed, and in the centre a great cavity encircled by a precipitous escarpement, he should be compelled to concede that the cone and crater-like configuration, whatever be its mode of formation, may sometimes have no reference whatever to ordinary volcanic operations."

Now, to expect the entire absence of igneous products from mountains so constituted seems somewhat unreasonable, for this would be requiring us to point out a cone which, though elevated by volcanic agency, was destitute of any of the more usual concomitants of such operations.

But if Mr Lyell will be content to abandon this part of his position, I shall not despair of presenting him with cases * which fulfil the other conditions which he lays down as necessary to establish the point.

Mr Scrope, in page 74. of his Memoir on Central France, has described "a circular lake, called Le Gour de Tazana, about half a mile in diameter, and from thirty to forty feet deep. Its margin for a fourth of the circumference is flat, and elevated above the valley into which the lake discharges itself. Every where else it is environed by steep granitic rocks, thickly sprinkled with small scoriæ and puzzolana, and rising about 200 feet from the level of the water. These fragments are all that indicate the volcanic origin of this gulf-like basin, but they are sufficiently decisive. No stream of lava, or even fragments of any large size, are perceivable."

Mr Scrope proceeds to remark, that this curious, and in Auvergne rare, variety of crater, is identical in its characters with some of the largest and most remarkable of the volcanic maare in the Eyfel, particularly that of Meerfeld; a crater which I had myself noticed in my work on volcanos, and which, according to the description there given, might be cited as a case fulfilling all the conditions required by Mr Lyell; but which I do not bring forward as such, because I have no right to prefer my own negative testimony, with regard to the absence of igneous products, to Mr Scrope's positive statement as to their occasional presence in it. It is, however, satisfactory, in the instance I have here alleged, to have the authority of a

* Von Buch and his disciples would also cite the dolomitic cones near Trent as instances of isolated rocks uplifted by volcanic action, and unaccompanied by volcanic products of the usual kind.

The difficulty, however, of admitting that part of his theory which supposes the penetration of an entire calcareous mountain with magnesia, in such a manner as to constitute a chemical compound in atomic proportions, makes me hesitate as to the fact itself of their having been uplifted, though I perceive that some geologists, who object to the elevation-theory, as applied to the trachytes of Auvergne, appear to adopt it with reference to these.—*See Considerations on Volcanoes; by Poulett Scrope, Esq. Sec. Geol. Soc. London,* 1825, p. 205, *et seq.*

geologist, who, by his objections to the elevation-theory, as applied to such cases as Jorullo or the Puy de Dome, has shewn a reluctance to admit this mode of explanation, except on what he considers the strongest grounds.

Upon the whole, then, there seems no reason to question, that, in volcanic districts, the common rocks of the country are sometimes heaved up around a circumscribed area; and if similar examples cannot be pointed out in other countries, it ought not to excite surprise, that, where all other indications of igneous action are wanting, this one should not occur.

Granting, then, the throwing up of a cone of trachyte to serve often in a manner as a prelude to the volcanic operations which we in general witness, an additional reason will exist for admitting, that such convulsions would have attended the first breaking out of a volcano in a new district, as might have brought about a very extensive flood, when a sea or lake was contiguous; but I am by no means obliged to stake the truth of this theory upon the admissibility of Von Buch's hypothesis, as the conclusions of M. Elie de Beaumont alone appear to me sufficient to lead to its adoption.

I contend, therefore, upon both these grounds, that a belief in the unchangeableness of the laws of nature is by no means incompatible with an admission of the diluvial theory in the sense in which I have here explained it; and that our want of experience as to the occurrence of such events in the present day no more excuses the rejection of the evidence from which our belief in them is derived, than a long exemption from famine or pestilence would justify a nation of savages, that possessed no historical records, in concluding the traditions of such calamities, which had been handed down to them by their forefathers, to be founded in error, and inconsistent with their actual knowledge.

From the very nature of things, the intervals between such catastrophes would be of long duration, as the events themselves would have required a combination of circumstances not often met with together; just as we are told by astronomers that the approach of a comet, sufficiently near our planet to produce a sensible influence on its climate, or affect the height or direction of its tides, although it may be expected to occur at some period or other, is extremely improbable at any given time.

If, then, a tradition had come down to us of a comet, which, by its approach to our globe, had occasioned fearful ravages on its surface, and if observation furnished nothing to contradict, but much to confirm, the *general* truth of the report, it would imply an excess of scepticism to deny the fact, merely because centuries had passed away without any similar event having taken place.

Nevertheless, I presume not to decide whether the phenomena in question are such as require us to have recourse to such an hypothesis; or whether, as others have contended, they admit of being more simply explained by reference to operations of which we are eye-witnesses.

It has long been my persuasion, that the formation of valleys, and the origin of sedimentary deposits, are questions of so complex a description, and involve such a variety of different considerations, that they can only be treated properly by those who have long directed their chief attention to geological pursuits, and have taken pains to make themselves fully masters of every point which the study embraces.

Now, with this feeling, it would ill become me to attempt to break a lance with Mr Lyell, on the general merits of the question he has so elaborately discussed, having for some time past been obliged, by the interference of other pursuits, to confine myself to those branches of geology which relate more or less immediately to volcanic operations, and being, therefore, indebted for most of the information I possess, respecting the details of diluvial action, to the investigations of others.

I am, therefore, quite ready to defer to the decision which naturalists may be disposed to adopt with respect to the origin of valleys in general, and am only prepared to contend, that the volcanic products met with in Auvergne are referable to two different periods, which, so long as the diluvial theory is admitted, must be viewed as being separated one from the other by the epoch of the deluge which overflowed that country.

One thing, at least, appears certain, namely, that the valleys of that district have resulted from the same cause or causes that produced them in the parts of France contiguous; and, therefore, so long as we refer them in other places to the operations of a deluge, we are entitled to call those volcanic products in

Auvergne, which evidently preceded the formation of the valleys, ante-diluvial, and those which succeeded them post-diluvial.

I am indeed fully aware, that some geologists, who admit that valleys in other countries have been produced by a deluge, regard those in Auvergne as the effect of the present rivers; but I am persuaded that no such line of separation, as is here attempted to be set up, will be found tenable, and that the diluvial theory, if received at all, must be extended to the valleys of Auvergne, as well as to the rest.

In vain would we contend, that the absence of any pebbles derived from rocks not met with in the neighbourhood, establishes a distinction between the two cases; for the same remark may be extended to a considerable proportion probably of those throughout France, as it is found to hold good with regard to many in other countries, where more attention has been directed to this inquiry.

Thus, whether we examine the valleys which occur in the neighbourhood of Auvergne, or extend our observation to those at a distance, as, for instance, in the Pyrenees, I imagine it will be found that the same remark, on which so much stress has been laid with regard to Auvergne, is applicable to many of them, namely, that the gravel is composed of pebbles derived apparently from the rocks in the neighbourhood, little or not at all intermixed with those from a distance. Yet, would it be fair to deny the diluvial origin of the valleys in the Pyrenees, whilst we are led by the presence of the granite blocks met with on the Jura, to allow it in the case of the Alps?

Or, to come nearer home, the pebbles of the *Leckie* have been traced along the valley of the Evenrode into that of the Thames, and hence have induced many to conclude, that, in this case, something more than the streams which now flow in the above situations, must at one time have been at work. But if it should be found that other parallel valleys, such as that of Moreton, contain none of these extraneous pebbles, would it be fair to contend that the origin of these latter was different? A more correct mode of reasoning would seem to be, that, supposing the fact stated to be received in general as a valid argument in favour of the reality of a deluge, the origin of the latter valley must be assumed as a sort of corollary from that of the former, the true question being, whether it be most easy to account for the absence of such pebbles in the one case, on the supposition of a general deluge, or their presence in the other, if we deny such an event to have taken place?

Let us suppose a Saussure or a Deluc, fresh from the Alps, to come to England uninformed with respect to the particular spots in which the diluvial gravel of this country has been found to contain rolled blocks derived from strata not met with in their neighbourhood. It is very possible that, under these circumstances, he might, in his first researches, light upon a district in which no such evidences of a distant current of water were to be found, or in which they were so rare, that, during a cursory visit, and with his attention divided by other objects, they should be overlooked. Yet it would be rash for him, in such a case, either to conclude that the valleys of Great Britain in general were formed by a different cause from those in the Alps, or, having persuaded himself by the phenomena exhibited amongst these his native mountains, that similar operations must have been general in other countries, to conclude that the particular spot he had chanced to examine, constituted an exception to the rule.

Even so, I contend that English geologists, passing from a country where the phenomena of diluvial action have been much studied, to one where they have been in a great degree neglected, ought not to be startled, if the first districts on which they chance to pitch, fail to present direct evidence of the kind they are in quest of. They should rather conclude, that the diluvial currents may have acted with their greatest force in a different direction, and have therefore transported the blocks in question elsewhere, and consequently be disposed to attribute the gravel, in this instance, to the same cause which they assign to it in other places, where more decided proofs of its origin are discoverable.

Such appears to be the line of argument which geologists have adopted in other analogous cases. Thus, when they have observed two contiguous valleys, the one placed under circumstances that appear to them to exclude the action of present streams, the other explicable by this supposition, equally as by that of the operation of a deluge, they have considered themselves authorized to refer the latter to that principle, which embraces both cases, rather than adopt two explanations for phenomena in other respects so analogous.

I have hitherto been arguing on the assumption that the valleys in Auvergne are really destitute of debris derived from a distant quarter; and that the negative evidence adduced to shew the total absence of such pebbles, resting as it does on authority, which, however respectable, is that of foreigners, such as Messrs Scrope, Murchison and Lyell (to which I ought in candour to add that of my own cursory examination this summer), is to be regarded as absolutely decisive.

Other observers, however, resident in the country, seem to have arrived at an opposite conclusion; for Messrs Deveze and Bouillet * are stated to have discovered, in various parts of the arrondissement of Issoire, fragments of Jura limestone, which, occurring in such a spot, furnish precisely the same proof of the action of a distant current, as the Leckie pebbles afford, when observed in the valley of Oxford.

To assert, therefore, in the present state of our knowledge, the absence of all proofs of diluvial action throughout Auvergne, would at least be hazardous; but, were the fact ever so well established, I still think that those geologists who contend against such a supposition, not on general grounds, but by evidence deduced from this particular district, should be required to prove, not only that the valleys in that country may have been produced by rivers, but likewise that the phenomena they exhibit are such as a deluge could not have given rise to.

Now, I apprehend the arguments adduced by the opponents of this theory belong sometimes to the former and sometimes to the latter of these heads; and that, by keeping in view this distinction between their real drift, we shall simplify considerably the question at issue, and be able more clearly to shew how far they may have succeeded in deciding it.

In referring to the facts which are adduced to prove that existing causes are competent to have occasioned the valleys in Auvergne, it is no more than justice in the first place to re-

* See the work by Messrs Croizet and Jobert on the Fossil Bones found in Auvergne.

mark, that we are much indebted originally to Mr Scrope, and afterwards to Messrs Murchison and Lyell, for shewing, in a more decisive manner than had before been done, the degree to which the accumulated waters of even a small stream are capable of eating into the substance of the most compact rocks.

As the exclusive consideration of one set of causes renders us less alive to indications of an opposite nature, it was the natural tendency of the diluvial theory to lead us to depreciate the operation of existing causes; and it cannot be doubted but that the collision of opinion has in this instance brought to light facts, which the influence of one exclusive system might have caused us for some time to overlook.

Important, however, as their observations may be with reference to the general question at issue, they have evidently no peculiar bearing on that respecting Auvergne, the analogy between the ravines in that district which Mr Scrope represents as formed by the present rivers, and the valleys contiguous to them, being much less close than that existing between the latter in this and in other countries.

I might therefore concede the whole of this part of the argument, without abandoning the position I have taken up in this memoir; but, as I chanced this summer to visit the neighbourhood of Pont Gibaud, whence Mr Scrope has derived some of his most striking proofs of the action of rivers, it may not be irrelevant to point out certain circumstances relative to the phenomena there exhibited, that seem to throw doubt upon his conclusions in certain cases, and limit the effects there attributable to causes now in action within a narrower circle than he is inclined to suppose.

I shall begin by observing, that, in order to shew that a lava current has been cut through by a river since the occurrence of a supposed deluge, it must be ascertained, 1*st*, That the coulée itself exists on both sides of the river; 2*dly*, That it has descended from a crater; and, 3*dly*, That the crater itself is composed of such loose materials, that it would have been washed away by any great body of water which might have overflowed the country.

Now, Mr Scrope has presented us with two examples near the town of Pont Gibaud, one of which fulfils all the required conditions, and establishes the fact that the River Sioule has worn a channel nearly fifty feet deep through a bed of lava which had interrupted its progress, derived from the crater of the Puy de Côme, the loose texture and perfect preservation of which establishes its post-diluvial origin.

In the second instance, that of Chaluzet, he has been less successful in making out his case; for although the lava which overhangs the river at this point is seen at the height of 240 feet on its right bank, not a trace of it is discoverable on its left, so that all we are entitled in this place to attribute to the action of the river since the date of the lava, is the wearing away of the subjacent gneiss, and probably the undermining and removal of the extreme portion of the current, which, as it rests upon a bed of pebbles, might have been effected without difficulty.

But what, after all, is the date of the lava here alluded to? The crater from which it is supposed to have proceeded certainly affords, in its imperfect condition, satisfactory proof of the extreme antiquity of the coulée, but it supplied me with no data from whence to determine the post-diluvial origin of the volcano which ejected it. The materials composing its summit, now called the Puy Rouge, possess by no means that want of coherence which we have noticed in some of the more modern Puys, as inconsistent with the idea of their ante-diluvial origin. They are, on the contrary, bound together, at least externally, in such a manner, by the soil resulting from their decomposition, and by the turf which covers them, that they appeared to me as capable of resisting the violence of such a catastrophe as any of the rocks in their neighbourhood.

I cannot, therefore, admit, that Mr Scrope is warranted in pronouncing such a crater as that of Chaluzet to be necessarily post-diluvial, unless, indeed, he is also prepared to maintain, that the existence of hills in any part of the world, whose summits consist of sandstone or the looser kinds of conglomerate, is irreconcilable with the notion of a deluge having swept over the country since they acquired their present form.

On the other side of Pont Gibaud, many geologists, and myself among the rest, notice the remarkable instance first correctly described by Montlosier, in which a kind of lake, called the *Etang de Fung*, would appear to have been formed by a stream of lava, which blocked up the course of the river, and compelled it to flow in quite a different direction.

"The baffled waters of the Sioule," says Mr Scrope, "here as at Pont Gibaud, obstructed by the rocky dike thrown across their channel, must have given rise to a lake by their stagnation, and would probably have ended, as in the other instance, by wearing away a passage parallel to their former one, had not the hill forming their western bank, not in this instance composed of granite, but of a soft alluvial tufa, yielded, at some distance up the stream, to the excessive pressure of the dammed up waters. An immense excavation, still subsisting, was broken across this hill, through which the lake emptied itself into the bed of the Monges at no great distance, and through which the Sioule still joins this latter stream, about three miles above their former confluence."

Now, that the accumulated waters of the Sioule, when arrested by this barrier, should have undermined, and thereby forced a passage through a rock of so very soft and yielding a nature as that of the argillaceous hill alluded to, is by no means surprising; neither need we doubt that the river may have worn a channel through the subjacent gneiss to the depth of 12 feet since the period at which its direction was changed.

But when the same conclusion is extended, as some geologists seem disposed to do, to the gorge of gneiss or the valley excavated in the plateau of ancient basalt, through which the river afterwards flows, I would ask, what proof have we, that, in these latter cases, the valley was not of anterior date, and whether, if it had not been already in existence, the river ought not to have surmounted the impediment opposed by the lava current of Côme, rather than to have worked its way through the more elevated and equally unyielding barrier to its left?

The most, therefore, we are entitled to conclude from the phenomena exhibited near Pont Gibaud with respect to the action of rivers upon the compacter kinds of rocks, is, that one recent lava-stream, namely that portion of the coulée from the Puy de Côme which is seen near the town, has, since an epoch more remote than that of the earliest records of the country, been worn by the action of the stream to the depth of about 50 feet.

Other instances are, however, given, in which the amount of the excavation has been as much as 70 feet, and in the Vivarais it is stated as still more considerable. Yet even here there must be allowed to be a wide distance between what the rivers are proved to have effected, and the depth to which many valleys, attributed on all hands to the operation of water, are seen to penetrate into the rocks which bound them.

Nor ought we to leave entirely out of the account the fact, that no excavation bearing any great resemblance to the general form and width of our valleys, has been shewn to have resulted from the action of the present rivers in Auvergne. All the instances adduced seem to be of narrow and abrupt ravines, which are strikingly distinguished from the easy and gradual slope of the valleys, at the bottom of which they are found; and though it may be contended, that, when the ravine had been worked to a certain depth, varying according to the nature of the rock, it would become undermined, and in this manner be gradually widened, until it acquired the shape and dimensions of an ordinary valley; yet it seems singular that, if the post-diluvial lavas of Auvergne are of the antiquity supposed, and if the ordinary effect of rivers is to produce in course of time such valleys, no instance should have been pointed out presenting a nearer resemblance to those of other countries, than the ravines depicted in Mr Scrope's volume.

This geologist, however, goes on to shew, that the valleys in Auvergne cannot have been formed by the action of a deluge, because the ancient, or, as I have called them, the ante-diluvial currents, are not all found nearly about the same general level. "Had the valleys," he contends, "been excavated by any one simultaneous cause, the lava-currents, which had flowed into the fresh water basin, would be found nearly, if not altogether, at one uniform level, and such as had flowed since at another nearly uniform level. Now, instead of this, the currents are found at all elevations, from 1500 to 15 feet above the present water-channel."

But Mr Scrope appears here to have forgotten what he had himself before established in his section of Gergovia, namely, that the fresh-water limestone went on forming after the volcanos had begun their eruptions.

Hence it is evident, that the level of the bottom of the lake would be gradually rising, so that the lavas of latest ejection would naturally occupy an higher position than the rest, and a body of water, which should have swept away in certain cases the upper beds, whilst it spared them in others, would produce precisely that irregularity of level, which is adduced as a decided objection to the possibility of a deluge.

With regard to the post-diluvial lavas, I am not aware of any case which lends support to Mr Scrope's position. It is true that they have not in every instance descended to the lowest level of the valley in which they are situated; but this circumstance may be seen explained by Messrs Murchison and Lyell, in their judicious remarks on the *Cheires* of Auvergne *, and may have very naturally arisen from the cooling of the lava having been completed, before it had time to continue its sluggish course to the extreme point. In a considerable number of instances, however, where any stream lay in the direction they took, they have actually reached its bed, and in these cases, as we have seen, the depth to which the river has since worked its way is an index of the amount of destruction effected since that remote period.

The other arguments of Mr Scrope, which appear to have the same drift, need not perhaps detain us so long. Thus, he states, that the strips of the fresh water formation, which rise from the plain of Limagne in long tabular hills, owe their preservation from denuding forces to the cappings of basalt they possess. Now, such a capping, he contends, although it might defend the subjacent stratum from rains, frost, &c. would form a very insufficient protection against the force of any violent deluge or general current of water.

But this argument, if of any force, is applicable in an equal degree to all other countries in which basaltic or other compact rocks occur, and comes therefore under the consideration of those who take up the question generally, rather than of those who limit themselves to the phenomena of Auvergne.

The existence of a crater in a tolerable state of integrity, especially when composed of loose scoriæ, is, I am ready to admit,

* Edinburgh Journal, July 1829.

a strong presumption that no deluge can have swept over the country since the origin of the volcano to which it belongs; and on this principle, I have already given Mr Scrope credit for pointing out to us the effects produced by rivers upon lava-currents, which, having descended from such craters, we presume to be post-diluvial. But, is the great mass of the volcanic products of Mont Dor or Cantal in this predicament? Has any geologist pretended to trace the vast sheets of basalt and trachyte which here cover the greater part of two departments, to any thing like a crater, or connect them with cones of scoriæ? So far from this having been done, it seems to me quite impossible to determine in what direction they began to flow, or to avoid suspecting that the circumstances under which they were ejected essentially differed from those which exist at present.

The examples, therefore, brought forward by Mr Scrope cannot affect the question concerning the origin of such valleys as these, which every one must allow to differ widely from the ravines he has pointed out to us, and which, from their perfect similarity to the valleys of denudation found in other countries, we are bound, in consistency, to attribute to one and the same cause.

I should, however, lay but little stress upon this classification of volcanic products, were it not true, that the distinction in their ages is found generally to be accompanied with corresponding variations in the characters belonging to them. That such is the case most geologists appear to admit, and even Mr Scrope, although he objects to it in theory, adheres to the distinction in practice.

That there are exceptions to the universality of this remark, I have in many places of my work admitted, but, generally speaking, it is certain, that those lavas, which I have termed *postdiluvial*, and which are posterior to the valleys of the country, put on the appearance of such melted matters as have flowed in the open air; whilst those to which I have given the name of *antediluvial*, seem, for the most part, to have been produced under a certain degree of pressure. If, as we may infer from Mr Scrope's own statements, the ancient lavas of Auvergne were ejected at the bottom of a fresh water-lake, and if that lake chanced to be of a certain depth, the compactness which in general characterizes these products may be accounted for by the pressure of the superincumbent water; but, as the same effect might result from the weight of a considerable bed of tuff or scoriæ, the occasional occurrence of compact lava beds, even amongst subaërial volcanos, need not so much surprise us. When, therefore, I remarked, that no genuine basalt had, to my knowledge, been found amongst the lavas of those volcanos which are at present in activity, and that their ejections do not appear to exhibit the same columnar arrangement which belongs to the igneous products of an earlier age, I by no means meant to deny the possibility of such occurring, but only to awaken attention to the point, in the hope that other observers might ascertain its truth or falsehood.

The distinction, however, which I have attempted to maintain* between that irregular prismatic structure, which is the mere result of contraction, and is so well exhibited in the modern lava of Niedermennig, and that of articulated columns which is derived apparently from the mutual pressure of spheroidal concretions, be it true or false, will not be overturned by the observation, that in some instances a void space exists between the respective columns of the last mentioned kind. For it is evident, that the compression which converted the spheres into polygons would take place whilst the material was yet soft, and that a further degree of shrinking might therefore be expected to occur, before it became perfectly cold.

This, I conceive, furnishes a sufficient reply to Mr Scrope's objection in page 149 of his Memoir on Central France, especially when backed by the ingenious observations of Mr Gregory Watt, published in the Philosophical Transactions for 1808, from which it appears, that, after a melted mass has become in a great degree consolidated, chemical affinities continue to develop themselves, and crystalline arrangements to take place.

But I trust I have already said enough to prevent misconstruction, in case I should in any subsequent treatise, in which it might be inconvenient to introduce remarks of a controversial nature, think proper to adhere to those views which I had taken

* See Description of Volcanos, p. 49. and 422.

up previously to the publication of the writings I have been obliged here to allude to. If I stood alone in these opinions, I might perhaps bow to the authority of individuals more exclusively devoted to the study of geology than myself, who have arrived at opposite conclusions; but when I see the best naturalists divided, and even some of those who adopt, to a certain degree, the views proposed to be substituted for the diluvial theory, compelled to call in the assistance of something of the same kind to explain certain refractory phenomena, I think it best for the present to retain my original views on these points, which are still espoused by the individuals who first gave them currency in this country, and which, whether true or false, serve at least to convey a clear conception of the relation existing between the volcanic products of the districts I have described.

I ought not, however, to conclude this long epistle, without bearing my humble testimony to the merits of the work which first induced me to address you, and expressing the satisfaction I have experienced in perusing a treatise on Geology, which, unlike some of those which preceded it, is distinguished no less for the number and general accuracy of its details, than for the philosophical spirit in which it is conceived.

I am quite prepared to admit, that the accounting for all the phenomena exhibited on the earth's surface, not only consistently with the present laws of nature (for on that point I suppose we are all agreed), but also without having recourse to any operations but those we are eye-witnesses of, constitutes in a manner the *beau ideal* at which our researches should aim, and would, if successful, elevate geology to the rank of the exact sciences. But we must be on our guard, nevertheless, not to be led away by the charm of simplicity, so as to overlook the difficulties which seem at present to stand in the way of such an explanation, and imagine the object within our reach, when it is seen only perhaps in distant and doubtful perspective.

Whether, too, the modifications which the author has chosen to introduce in the Huttonian Theory be an improvement in it, seems to me questionable; but be that as it may, the surviving supporters of that hypothesis will welcome with acclamation a disciple who has maintained, with so much skill and research, the leading positions of their system; and I am sure that, if its illustrious founder were now alive, he would testify as much delight as at the discovery of the granite dikes of Glen Tilt, when he saw the conclusions, which he had deduced from a more imperfect survey of geological phenomena, rendered popular in the south by the ingenious reasonings of one, whom, though he cannot certainly be said to belong to the "Oxford School of Geology," as it is somewhere called, Alma Mater will, I am sure, be always proud to number among her sons.

OXFORD, *Jan.* 15. 1831.

On the Characters and Affinities of certain Genera, chiefly belonging to the Flora Peruviana. By Mr DAVID DON, Librarian to the Linnean Society, Member of the Imperial Academy Naturæ Curiosorum, of the Royal Botanical Society of Ratisbon, and of the Wernerian Society of Edinburgh, &c. (Concluded from p. 122.)

QUILLAJA and KAGENECKIA.

THESE genera, together with *Vauquelinia*, I consider as constituting a small family, differing essentially both from *Rosaceæ* and *Spiræaceæ* in their erect ovula, and from the latter, also, in the valvular æstivation of their calyx. The habit of the plants composing it is likewise abundantly different, and they are mostly inhabitants of the southern hemisphere. This family may be termed *Quillajeæ* and it may be characterised as follows:

QUILLAJEÆ.

SPIRÆACEARUM PARS. *Kunth et Dec.*

CALYX 5-fidus, æstivatione valvatus.

PETALA 5, laciniis calycinis alterna; quandoque nulla.

STAMINA definitè numerosa (10 v. 15) calyci inserta: *antheræ* biloculares.

PISTILLUM: *ovaria* 5, basi connata, unilocularia: *ovula* numerosa, erecta: *styli* 5: *stigmata* totidem, unilateralia, papillosa.

FRUCTUS: *folliculi* 5, in circulum digesti, basi connati.

SEMINA duplici ordine suturæ folliculorum internæ inserta, adscendentia, apice alata: *umbilico* basilari: *testa* simplex, membranacea: *albumen* nullum.

EMBRYO erectus: *cotyledones* foliaceæ, contrariè convolutæ: *radicula* cotyledonibus brevior, teres, umbilico proxima.

Arbores (præcipuè Amer. Austr.) Folia *alterna indivisa.* Stipulæ *minimæ, caducæ.* Flores *terminales, dioici.*

QUILLAJA, *Mol. Juss.*

SMEGMADERMOS, *Ruiz et Pavon.*

SMEGMARIA, *Wild.*

Calyx 5-fidus: *laciniis* ovatis, obtusiusculis, crassis, densè tomentosis, margine truncatis, æstivatione valvatis: *discus* ibidem connatus, stellæformis, 5-lobus, carnosus, glaber, coloratus, nectariferus? è basibus dilatatis filamentorum alternorum constitutus, ejusdemque lobis a calyce parùm elevatis, subrotundis, emarginatis! *Petala* 5, calycinis laciniis alterna, spathulata, unguic ulata. *Stamina* 10, duplici ordine disposita; 5 *exteriora* loborum disci emarginaturis, et hinc medio calycinarum laciniarum inserta; *cætera* fauci calycis tomentosæ inserta, petalisque opposita: *filamenta* subulata, glabra: *antheræ* introrsæ, biloculares, peltato modo insertæ: *loculis* apice confluentibus, rimâ longitudinali dehiscentibus. *Ovaria* 5, tomentosa, in unum 5-angulum quasi connata. *Styli* 5, distincti, compressi, glabriusculi, terminales, subinde maturescenti fructu unilaterales. *Stigmata* totidem, unilateralia, recurvato-patentia, minutissimè papillosa. *Fructus: folliculi* 5, connati, patentes, stylo unilaterali, persistenti instructi, uniloculares, polyspermi, suturâ filiformi utrinque dehiscentes: *valvis* ventricosis, crustaceis, intùs politis. *Semina* basi interiori loculorum inserta, adscendentia, apice alâ obliquâ membranaceâ punctatissimâ instructa: *umbilico* basilari: *testâ* simplici, crustaceâ. Cætera ut in ordine.

Arbores (Chil. et Bras.) *sempervirentes.* Folia *alterna, petiolata, indivisa.* Stipulæ 2, *petiolares, caducæ.* Flores *corymbosi.*

1. Q. *saponaria*, foliis ovalibus plerumque dentatis.

Quillaja saponaria, *Mol. Hist. Nat. Chil.* p. 182. ed. 2. 298.—*Poir. Dict.* 6. p. 33.

Q. smegmadermos, *Decand. Prod.* 2. p. 547.

Smegmadermos emarginatus, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 288. *Gen.* p. 141. t. 31.

Smegmaria emarginata, *Willd. Sp. Pl.* 4. p. 1123.—*Spreng. Syst. Veg.* 2. p. 440.

Hab. in Chili sylvis copiosè in Rere et Puchacay provinciis.—*Ruiz et Pavon.* ♄. Floret a Decembre ad Februarium. Vulgò Quillai s. Cullay. (V. s. sp. in Herb. Lamb.)

Arbor procera (60-pedalis), frondosissima, sempervirens. *Ramuli* teretes, pubescentes. *Folia* alterna, petiolata, ovalia v. raro oblonga, obtusa, sæpiùsque emarginata, margine plerumque dentata, sæpè tamen integerrima, coriacea; *juniora* leviter velutina; *adulta* utrinque glabra, viridia, lucidula, costâ subtùs prominulâ venisque angulo acuto obliquè transversis vix conspicuis, sesquipollicaria, pollicem lata. *Petioli* brevissimi, vix lineam longi. *Stipulæ* 2, parvæ, lanceolatæ, acutæ, membranaceæ, canaliculatæ, puberulæ, fuscescentes, caducæ, petiolo cuique adnatæ vix longiores. *Flores* albi? plerumque terminales, subsolitarii, aut plures (3 v. 5) corymbosi. *Pedunculi* semunciales cum pedicellis brevissimis angulati, densè velutini, incani. *Bracteolæ* oblongæ, obtusæ, canaliculatæ, coriaceæ, tomentosæ, deciduæ. *Petala* vix calyce longiora.

OBS. 1. Cortice saponis loco ad vestimenta lanea mundificanda incolæ utuntur; et ex eodem contuso globulos magnos conficiunt et dimidio regali singulos venditant.—*Ruiz et Pavon*, l. c.

OBS. 2. Folia exsiccata sæpè colorem æruginosum usurpant. Testa seminis embryone increscente sæpè basi disrupta!

Planta a Molinâ pessimè descripta.

2. Q. *lancifolia*, foliis lanceolatis acutis.

Hab. in Brasiliâ.—*Sello.* ♄. (V. s. sp. in Herb. Lamb.)

Arbor facie peculiari ferè ad Persoonias quibusdam accidens. *Ramuli* teretes, pube tenerrimâ vestiti. *Folia* alterna, petiolata, lanceolata, acuta, cartilaginea, utrinque glaberrima, costâ venisque obliquè rectis, prominulis, ramosis instructa, suprà viridia, lucida, subtùs pallidiora, opaca, basi attenuata, 2–3-pollicaria, semunciam vix ultra lata: margine obtuso, calloso, parùm incrassato, integerrimo, v. raro nonnullis prominentiis (dentibus obsoletis) ornato. *Petioli* 2–3 lineas longi, suprà planiusculi. *Stipulæ* 2, parvæ, oblongæ, cartilagineæ, fuscescentes, caducæ. *Flores* 5 v. 7, corymbosi, terminales et axillares, sed plerumque axillares. *Pedunculi* vix semipollicares, angulati, *calycesque* densè velutini, incani. *Ovaria* 5, densè tomentosa, coalita. *Petala* calyce longiora. *Disci lobi* crassiores, magisque elevati. *Stamina* longiora. *Filamenta alterna* parùm infra loborum disci apices inserta. *Styli* pubescentes, recurvato-patentes, paullò crassiores. Cætera omnino ut in genere.

KAGENECKIA, *Ruiz et Pavon.*

Calyx crateriformis, extùs 10-costatus, fructu maturescenti auctus! persistens: *limbo* 5-fido, intùs annulo parùm elevato, vix membranaceo, ovaria circumcingenti instructo: *lobis* ovatis, acuminatis v. obtusis, recurvato-patulis. *Petala* nulla? *Stamina* definitè numerosa (15); *quorum* 5 lobis calycinis alterna; *cætera* per paria lobis iisdem opposita: *filamenta* subulata compressa, persistentia, basi dilatata, et in annulum conferruminata, atque subinde totum indumentum faucis et cavitatis calycis constituunt: *antheræ* cordato-oblongæ, introrsæ: *loculis* basi solutis, divergentibus, ad apicem usque distinctis, nec confluentibus, longitudinaliter dehiscentibus. *Ovaria* in circulum digesta, unilocularia: *ovulis* pluribus, erectis. *Styli* compressi, glabri, terminales. *Stigma* complicatum, ferè ut in *Delphinio*, disco cucullato, demùm marginibus reflexis convexo, densè papilloso. *Capsulæ* 5, folliculares, omninò ut in *Pæoniâ*, densè sericeo-tomentosæ, exteriùs maximè productæ, et subinde stylus quasi unilateralis, polyspermæ. *Semina* apice membranaceo-alata, samaroidea, angulo interiori loculi inserta, imbricata, declinato-horizontalia: *umbilico* basilari: *testa* simplex, ob interiorem exteriori intimè adhærentem, membranacea: *albumen* nullum. *Embryo* erectus, lutescens: *cotyledones* subrotundo-cordatæ, foliaceæ, costâ prominenti subcarinatæ, contrariè convolutæ! inæquilateræ, sesquilineam latæ; *lobo altero* minore, accumbenti: *radicula* teres, crassa, obtusissima, cotyledonibus triplò brevior, centripeta. *Plumula* conspicua.

Arbores (Amer. Austr.) Folia *alterna, simplicia, impunctata, serrulata*: denticulis *glandulosis.* Stipulæ *minimæ, glandulæformes, caducæ.* Flores *terminales, polygami.*

Obs. Dubito anne flores verè omninò apetali, atque in eadem v. diversâ arbore sexu distincti.

1. K. *oblonga*, foliis oblongis obtusis coriaceis: denticulorum glandulis deciduis, floribus solitariis.

Kageneckia oblonga, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* I. p. 289.

Lydæa Lyday, *Mol. Hist. Nat. Chil.* ed. 2, 300.

Hab. in Chili montibus ad Conceptionis urbem.—*Ruiz et Pavon.* ♄. Floret ab Augusto in Decembrem. *Vulgò* Guayo Colorado, et ex Molinâ Lyday dicitur. (V. s. sp. in Herb. Lamb.)

Arbor 6-orgyalis, sempervirens. *Folia* petiolata, oblonga, v. rariùs obovata, obtusa, serrulata, denticulis apice glandulâ acutâ, deciduâ instructis, hinc quasi obtusis, et subinde folia obtusè serrata ab auctoribus suprà citatis dicata; coriacea, rigida, glabra, subtùs pallidiora fereque glauca, basi attenuata, costâ validâ utrinque prominenti, venis transversè arcuatis, ramosissimis reticulata, pollicaria v. tripollicaria, vix pollicem lata. *Petioli* brevissimi, vix 3 lineas longi, costâ utrinque elevatâ, marginati, denticulis obsoletis. *Flores* in apice ramulorum solitarii. *Pedunculi* semunciales, angulati, brevissimè pubescentes, apice in calycem dilatati. Cætera ut in genere.

Obs. Ex truncis optimæ trabes ad ædificia construenda extrahuntur. Folia amarissima et ad febres intermittentes depellendas præscribi possunt, ad quem usum speciem sequentem incolæ Peruviani adhibent.—*Ruiz et Pavon*, l. c.

2. K. *lanceolata*, foliis lanceolatis obovatisve membranaceis: glandulis denticulorum persistentibus, floribus corymbosis.

Kageneckia lanceolata, *Ruiz et Pavon Syst. Veg. Fl. Peruv. et Chil.* 1. p. 290. Gen. p. 145. t. 37.

Hab. in Cantæ Provinciæ Peruvianorum collibus.—*Ruiz et Pavon.* ♄. Floret Novembri et Decembri. (V. s. sp. in Herb. Lamb.)

Arbor 3-orgyalis. *Folia* alterna, petiolata, obovata v. lanceolata, acuta, rarò obtusa, eleganter crebrèque serrulata, serraturis antrorsis glandulâ persistenti terminatis; membranacea, utrinque glabra, lævissima, suprà viridia, vix polita, subtùs pallidiora et pulchrè venulosa, pollicem v. tripollicem longa, semi v. sesquipollicem lata; a Salice myrsiniti ad S. triandram formâ variantia. *Petioli* suprà concavi, subtùs convexi, lineam v. sesquilineam longi, margine obsoletè denticulati. *Stipulæ* 2, minimæ, 3–4-dentatæ, glundulæformes. *Flores* 3- v. 5. subcorymbosi, pedunculati. *Pedunculi* sesquipollicares, glabri, angulati, apice sub calyce incrassati. *Calyx* crateræformis: *laciniis* ovatis, acuminatis, acumine recurvato, extùs parcè puberulis, intùs densè tomentosis. Cætera ut in genere.

THEOPHRASTA and CLAVIJA.

Mr Lindley has already defined the limits of these two genera in a most satisfactory manner, and I have nothing to add to the descriptions of them by that eminent botanist, except that I find the ovarium to be uniformly one-celled in both, and furnished with a central placenta, originating solely from the confluence of the umbilical cords with the pistillary column, having no trace whatever of a partition. A close relationship between these two genera and *Jacquinia*, being clearly established by their unilocular ovarium, alternate leaves, peltate seeds, and copious horny albumen, with an erect embryo, there cannot, I think, be any question as to the propriety of referring them to *Myrsineæ*; of the correctness of which arrangement Mr Lindley seems now fully aware, although, in his excellent *Collectanea Botanica*, he referred them to *Strychneæ*, to which, no doubt, they both bear also very considerable affinity in their peltate seeds, copious horny albumen, and foliaceous embryo, and in the form and structure of their ripe fruit; but they differ essentially in their unilocular ovarium, and in having alternate leaves. As to the æstivation of corolla, it appears to be only of generic importance in *Strychneæ*, for in *Strychnos* it is valvular, while in *Carissa* we have the twisted and imbricate æstivation of *Apocineæ*. I consider the *Strychneæ* as forming an osculant group between *Apocineæ* and *Myrsineæ*, but abundantly distinct from either, to entitle them to rank as a separate family.

The late Sir James Edward Smith has expressed, in Rees's Cyclopædia, a suspicion of Jacquin's *Theophrasta longifolia* being identical with the *Eresia* of Plumier, the *Theophrasta americana* of Linnæus; but this last having a large, polyspermous berry, and the former having seldom more than two seeds in each, completely sets the question at rest as to their specific difference at least. For ripe fruit of the former, namely *T. longifolia* of Jacquin, I am indebted to Mr Fanning, who collected them in Caraccas last year.

THEOPHRASTA, *Juss.* (an etiam *Linn.* ?)

Calyx campanulatus, 5-partitus, vascularis, cartilagineo-coriaceus: *laciniis* elliptico-oblongis, margine erosè denticulatis, æstivatione imbricatis. *Corolla* campanulata, vascularis: *tubus* brevissimus: *faux* dilatata, pentagona: *limbo* patulo, 5-lobo: *lobis* rotundatis, margine erosè crenulatis, æstivatione imbricatis. *Corona* annulus elevatus, angulato-lobatus, carnosus, fornicatus, faucem circumcingens. *Stamina* 5, tubo inserta: *filamenta* compressa, infernè dilatata et cum tubo corollæ connata: *antheræ* ovato-oblongæ, biloculares, extrorsæ! duplici rimâ longitudinaliter dehiscentes, appendice rostelliformi, obtusâ, e filamenti apice s. connectivi elongatione, ortâ coronatæ! *Pollen* farinaceum: *Pistillum* 1: *ovarium* liberum, subrotundum, uniloculare: *ovulis* numerossimis: *stylus* teres, subattenuatus: *stigma* capitatum. *Bacca* sphærica, crustacea, unilocularis, evalvis, polysperma, irregulariter rumpens. *Semina* peltata, placentæ magnæ, centrali, succulentæ subimmersa, propè basin interiorem chalazâ cavâ instructa: *testa* simplex, membranacea, superficie mucilaginosa: *albumen* copiosum, corneum. *Embryo* erectus, parùm excentricus: *cotyledones* foliaceæ: *radiculâ* cylindraceâ, obtusâ, vagâ.

Arbusculæ (Antill.) *non lactescentes, more* Palmarum caule *simplici, comâ frondosâ, sempervirenti.* Folia *alternatim conferta, undique versa, patentia, subverticillata, subsessilia, oblonga, coriacea, rigida, glabra, lætè viridia, pedalia v. sesquipedalia, margine undulata et copiosè dentato-spinosa, dentibus magnis, subdivaricatis:* basi apiceque *sæpiùs truncatis; subtùs pallidiora, lævissima, costâ crassissimâ, elevatâ, obtusâ, venis immersis: suprà præsertim siccitate reticulato-venosa, venis subinde prominulis.* Flores *terminales, racemosi.* Racemi *plures intra folia reconditi, multiflori, brevissimi, vix bipollicares.* Corolla *hujus ordinis maximi, albi.* Bacca *magnitudine* Pomi sylvestris, *lutescens.*

1. T. *Jussiæi.*

Theophrasta Jussiæi, *Lindl. Coll. Bot.* t. 26.
T. americana, *Linn. Sp. Pl.* i. p. 212? *Swartz. Obs.* p. 58.
T. Henrici, *Ham. Prod. Fl. Ind. Occid.* p. 27.
Eresia foliis aquifolii longissimis, *Plum. Gen.* p. 8. t. 25? *Icon.* t. 126?
Hab. in Hispaniolæ montibus. *D. Lahaye, Gulielmus Hamilton.*
♄. *Vulgò* Le Petit Coco. (V. v. cum flore, et s. sp. cum fructu in Herb. Lamb.)

I am still disposed to consider the *Theophrasta* of Linnæus as identically the same genus, if not the same species with that of Jussieu. Plumier states the corolla of his *Eresia* to be campanulate, and so it is represented in the figure, an expression which could not apply to the corolla of any species of *Clavija*, nor would so accurate an observer as Plumier have overlooked the remarkable union of the stamens in the latter genus; and although the rude representation published by Burmann has the flowers very much smaller, and in longer racemes, yet the figure of the fruit, and the general outline of the leaves, accord precisely with the plant of Jussieu. The disposition of the fruit in the figure itself, shows that the spike of flowers is indebted to the imagination of the engraver for part of its length. No mention is made of the place whence Plumier obtained his *Eresia*, but as it is known that he only visited Martinique and St Domingo, it is very probable that he found it in the latter island.

CLAVIJA, *Ruiz et Pavon.*

THEOPHRASTÆ Sp. *Auct.*

Calyx 5-partitus: *laciniis* suborbiculatis, concavis, tenuissimè et erosè serrulatis, æstivatione imbricatis. *Corolla* rotata: *tubus* brevissimus: *limbus* 5-lobus: *lobis* subrotundis, carnosis, margine tenuissimè crenulatis, æstivatione imbricatis. *Corona faucis* 10-loba: *lobis* obtusis, carnosis, suprà sæpè sulcis antheris impressis exaratis! conniventibus, faucem omninò operientibus. *Stamina* 5, tubo insertæ: *filamenta* in tubum pyramidatum omninò connata! *antheræ* trigonæ, biloculares, in discum stellatum cohærentes: *loculis* subtùs adnatis, cartilagineis, bivalvibus, tumidis, longitudinaliter dehiscentibus, apice confluentibus, basibus solutis, vix productis; *defloratis* profundè bisulcatis, hinc posticè quadrilobis! *Pistillum* 1: *ovarium* liberum, uniloculare: *ovulis* numero indeterminatis: *Stylus* apice attenuatus: *Stigma* exiguum, truncatum, minutè papillosum. *Bacca* globosa, crustacea, unilocularis, evalvis, polysperma, nunc rariùs mono v. disperma! Cætera ut in præcedente.

Frutices (Amer. Æquin.) *non lactescentes.* Caulis *simplicissimus, more* Palmarum *apice frondosus.* Folia *alternatim conferta, undique patentia, oblonga, coriacea, glabra, reticulato-venosa, margine dentato-spinosa v. integerrima.* Petioli *basi callosi.* Flores *terminales, racemosi, albi aut aurantiaci.*

Flores in omnibus exemplaribus a me visis hermaphroditi, et nunquàm dioici sunt, ut dicant auctores Floræ Peruvianæ.

Obs. 1. Annulus corollæ faucis è plicis loborum limbi ejusdem certè ortum ducens.

Jacquinia cum Theophrastâ et Clavijâ omninò congruit calyce et corollâ æstivatione imbricatis, fauce corollæ coronatâ, baccâ crustaceâ uniloculari evalvi, seminibus peltatis placentæ centrali insertis, testâ simplici superficie mucilaginosâ, embryone erecto ferè in axi albuminis magni cornei, cotyledonibus foliaceis, radiculâ cylindraceâ vagâ; atque foliis margine callosis, in apice ramorum confertis, petiolisque basi incrassatis.

Obs. 2. Flores et Semina Jacquiniæ et Clavijæ exsiccata, aquâ tepidâ madida odorem *Primulæ veris* maximè redolent!

* *Foliis margine integerrimis.*

1. *C. macrocarpa*, foliis spathulato-oblongis acutis rigidis subtùs punctatis, petiolis vix pollicaribus, racemis longissimis pendulis.

Clavija macrocarpa, *Ruiz et Pavon. Syst. Veg. Fl. Peruv. et Chil.* i. p. 284. *Gen. t.* 30.

Hab. in Cuchero et Munæ Peruviæ nemoribus. *Ruiz. et Pavon.* ♄. *Vulgò* Lucuma de Monte. Floret Augusto et Septembri. (V. s. sp. in Herb. Lamb.)

Frutex biorgyalis. *Folia* spathulato-oblonga, acuta, integerrima, margine cartilagineo, latiusculo, acuto, subreflexo, valdè coriacea, rigida, reticulato-venosissima, pedalia v. sesquipedalia, subtùs punctis impressis, numerosis, costâ mediâ validissimâ. *Petiola* vix unciales, crassi, callosi. *Racemi* numerosi, penduli, spithamæi v. pedales, glabri. *Flores* quàm in cæteris duplò majores. *Bacca* globosa, polysperma, *pomi sylvestris* magnitudine, in Fl. Peruv. Gen. t. 30. depicta.

2. *C. longifolia*, foliis spathulato-lanceolatis acuminatis submembranaceis, petiolis tripollicaribus, racemis erectis pubescentibus.

Clavija longifolia, *Ruiz et Pavon. Syst. Veg. Fl. Peruv. et Chil.* i. p. 284.

Hab. in Pati et Macoræ Peruviæ runcationibus. *Ruiz et Pavon.* ♄. Fl. Augusto et Septembri. (V. s. sp. in Herb. Lamb.)

Frutex 8-pedalis. *Folia* sesqui v. bipedalia, infernè attenuata, quàm in præcedente substantiâ magis tenuiora, ferè membranacea, latitudine palmaria et sæpè ultrà. *Racemi* erecti, subspicati, puberuli. *Flores* sparsi, multò minores. *Bacca* polysperma, *Cerasi* magnitudine.

3. C. *spathulata*, foliis oblongo-spathulatis obtusis, petiolis sesquipollicaribus, racemis erectis læviusculis.

Clavija spathulata, *Ruiz et Pavon.* l. c. p. 285.

Hab. in Puzuzo et Munæ Peruviæ sylvis. *Ruiz et Pavon.* ♄. Fl. Septembri et Octobri. (V. s. sp. in Herb. Lamb.)

Frutex 3-ulnaris. *Folia* pedalia, v. ultrà, latitudine 5-pollicaria, submembranacea. *Petioli* nunc bipollicares. *Racemi* erecti, glabri, 3-4 pollicares. *Bacca* polysperma, *Cerasi* magnitudine.

4. C. *pendula*, foliis lanceolatis, racemis longis pendulis. *Ruiz et Pavon.* l. c. i. p. 285.

Hab. in Pozuzo Peruviæ nemoribus imis. *Ruiz et Pavon.* ♄. Fl. Septembri et Octobri.

Frutex 4-pedalis et ultrà.

* * *Foliis margine dentato-spinosis.*

5. C. *ornata*, foliis elongato-lanceolatis acutis spinoso-dentatis, petiolis unguicularibus, racemis pendulis, baccis subdispermis.

Theophrasta longifolia, *Jacq. Coll.* iv. p. 136. *Hort. Schœnb.* i. t. 116. *Spreng. Syst.* i. p. 670.

Hab. ad Caracas. *Jacquin, D. Faning.* ♄. (V. s. sp. in Herb. Lamb.)

Caulis simplicissimus, 12-pedalis. *Folia* sesquipedalia, basi acuta. *Racemi* 3-9-pollicares. *Flores* aurantiaci. *Bacca* magnitudine *Cerasi minoris*, subglobosa, crustacea, lateribus parùm compressa, unilocularis, evalvis, plerumque disperma, raro mono v. trisperma, basi calyce et apice stylo persistentibus instructa: *crusta* intùs virens, nervis venisque plurimis peragrata. *Semina* peltata, connata, substantiâ pulposâ copiosâ tecta, subinde drupacea! aquâ tepidâ madida pulpa exiit voluminosa, basi chalazâ amplâ concaviusculâ orbiculatâ notata: *testa* cartilaginea: *albumen* magnum, corneum, pelliculâ membranaceâ arctè adhærenti vestitum. *Embryo* erectus, axilis, lacteus: *cotyledones* ovales, subfoliaceæ: radiculâ cylindracea, obtusa, cotyledonibus subæqualis.

6. C. *undulata*, foliis cuneato-lanceolatis acuminatis spinoso-dentatis, petiolis semipollicaribus.

Clavija sp. nova, *Herb. Ruiz et Pavon.*

Hab. in Guayaquilâ. *Joannes Tafalla.* ♄. (V. s. sp. in Herb. Lamb.)

Folia vix pedalia, spathulato-oblonga, acuminata, basi acuta, margine sinuato-dentata, undulata: *dentibus* spinosis: *Petioli* semunciales. Flores nondùm vidi.

RAUVOLFIA.—*Fl. Peruv.*

With the professed object of giving an amended character of *Rauvolfia*, Ruiz and Pavon have described and figured a genus of plants possessing no affinity whatever with that of Linnæus. It is difficult to account for the reasons which led them to commit so grave an error, as the habit and characters of the two genera are so widely different. A careful examination of authentic specimens, both in flower and fruit, of the species described and figured in the *Flora Peruviana*, has satisfied me that they are referable to the *Verbenaceæ*, and that they are not generically distinct from *Citharexylum*, a genus which appears to have been destined to be confounded with *Rauvolfia*, for Willdenow, as we find from M. Kunth, in the *Nova Genera et Species Plantarum*, had referred certain species of the former to the latter genus. All the species of *Citharexylum* agree in having the limb and throat of the corolla thickly bearded, and the leaves simple, with their footstalks thickened and articulated at the base to the stem, indicating thereby another close analogy to the *Jasmineæ*, forming part of the same natural class, which likewise comprises *Selagineæ*, *Oleinæ*, and *Columelliaceæ*.

CITHAREXYLUM, *Linn.*

RAUVOLFIA, *Ruiz et Pavon.*

Syst. Linn. DIDYNAMIA ANGIOSPERMIA.
Ord. Nat. VERBENACEÆ, *Brown.*

Calyx campanulatus, 5–7-dentatus. *Corolla* calyce longior, tubulosa : *limbo* 5-lobo, patenti, suprà cum fauce densè barbato : *lobis* subæqualibus, retusis, æstivatione imbricatis. *Stamina* 5 v. 4, subæqualia, fauci inserta : *filamenta* brevissima, glabra : *antheræ* lineares, obtusæ, biloculares : *loculis* internè longitudinaliter dehiscentibus, basi solutis, tandem subdivergentibus. *Pistillum* 1 : *ovarium* 4-loculare : *ovulis* solitariis : *stigma* capitatum, minutè papillosum. *Drupa* dipyrena : *nuculis* osseis, bilocularibus, hinc convexis, sulcatis, inde planiusculis : *loculis* monospermis, basi interiore fossulâ cum stylo cummunicanti, substantiâ cellulosâ farctâ, instructis ; *testâ interiori* membranaceâ, cellulosâ : *albumen* nullum. *Embryo* erectus, lacteus : *cotyledones* oblongæ, plano-convexæ : *radiculâ* inferâ, cylindraceâ, parùm attenuatâ, rectâ, cotyledonibus ter breviori.

Arbores v. Frutices (Amer. Calid.). Ramuli *sæpè abortivi, spinescentes.* Folia *opposita, indivisa.* Petioli *basi callosâ manifestè articulati.* Flores *terminales, racemosi* v. *solitarii.*

1. C. *flexuosum*, spinosum ; foliis elliptico-oblongis mucronulatis integerrimis subtùs tomentosis, racemis paucifloris, calycibus 5-dentatis.

Rauvolfia flexuosa, *Ruiz et Pavon Fl. Peruv. et Chil.* ii. p. 26. t. 152. f. a.

Hab. in Peruviæ fruticetis ad Huanuci urbem, et in Provinciis Huamalies et Tarmæ. *Ruiz et Pavon.* ♄. *Vulgò* Turucasa, i. e. spina obtusa. (V. s. sp. in Herb. Lamb.)

Frutex biorgyalis, ramosissimus, spinosus. *Folia* pollicaria, v. sesquipollicaria, suprà rugosa. *Flores* parvi, ochroleuci, odore suavissimo. *Drupa* atropurpurea.

2. C. *retusum*, spinosum ; foliis obovato-oblongis retusis integerrimis subtùs tomentosis, racemis paucifloris, calycibus 5-dentatis.

Rauvolfia macrophylla, *Ruiz et Pavon* l. c. 2. p. 26, t. 152. f. b.

Hab. in Peruviæ collibus arenosis versus Atiquipa tractus. *Joannes Tafalla.* ♄. *Vulgò* Chama et Spino de Cruzes. (V. s. sp. in Herb. Lamb.)

Frutex biorgyalis, spinosus. *Folia* sesqui v. tripollicaria, rugosissima. *Spinæ* validiores. *Racemi* nunc multiflori. *Flores* lutescentes, majores. *Drupa* nigra.

3. C. *dentatum*, inerme ; foliis obovato-oblongis dentatis glabris, racemis multifloris, calycibus angulatis multidentatis.

Rauvolfia dentata, *Tafalla MSS.*

Hab. in Peruviâ ad Maccos, 1794. *Joannes Tafalla.* ♄. (V. s. sp. in Herb. Lamb.)

Frutex inermis, erectus, ramosissimus. *Folia* obovato-oblonga, dentata, v. rariùs subintegerrima, valdè coriacea, rigida, utrinque glabra, nitida, pollicaria v. paullò ultrà. *Racemus* multiflorus. *Calyx* angulis prominentibus, limbo acutè 6–7-dentatus.

4. C. *Lycioides*, inerme ; foliis lineari-lanceolatis obtusis integerrimis glabris, racemis paucifloris, calycibus integris.

Rauvolfia sp. nova, *Pavon. MSS.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Frutex inermis, virgatus. *Ramuli* cortice cinereo-albicanti. *Folia* margine integerrima, parùm revoluta, vix uncialia. *Drupa* nigra.

5. C. *lucidum*, inerme; foliis elliptico-oblongis obtusis basi acutis utrinque glabris, spicis elongatis nutantibus.

Citharexylum cinereum, *Sesse et Mocinno MSS.* non *L.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia 3–4-pollicaria, suprà lucida, subtùs reticulato-venosissima, apice mucronulo perbrevi instructa. *Petioli* unciales. *Spicæ* palmares.

6. C. *Sessæi*, inerme; foliis ovatis acuminatis subtùs pubescentibus, spicis elongatis nutantibus, ramis tetragonis.

Citharexylum quadrangulare, *Sesse et Mocinno MSS.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia sesqui v. tripollicaria, membranacea, pubescentia, suprà demùm nudiuscula, pinnatè nervosa, basi obtusiuscula. *Spicæ* palmares.

Obs. A C. pulverulento et quadrangulo omninò diversum.

7. C. *affine*, inerme; foliis ovato-lanceolatis acutis membranaceis glabris, spicis elongatis nutantibus.

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia 2–4-uncialia, acuta, membranacea, glabra, basi acuta, pinnatè nervosa. *Spicæ* 5-pollicares, nutantes.

8. C. *Mocinni*, inerme; foliis ovato-lanceolatis acuminatis subtùs tomentosis basi rotundatis, spicis elongatis pendulis.

Citharexylum tomentosum, *Sesse et Mocinno MSS.* non *Kunth.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia ampla, ovato-lanceolata, acuminata, integerrima, coriacea, suprà glabra, nitida, subtùs ramulisque densè fulvescenti-tomentosa, dodrantalia. *Spicæ* tomentosæ, pendulæ, pedales et ultrà. *Calyx* pentagonus: *denticulis* prominentibus.

9. C. *scariosum*, inerme; foliis ellipticis mucronatis coriaceis glabris, spicis erectis paniculatis.

Citharexylum scariosum, *Sesse et Mocinno MSS.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia 2–3-pollicaria, venis prominulis. *Petioli* breves. *Spicæ* erectæ, 3–5-unciales.

10. C. *ellipticum*, inerme; foliis subsessilibus obovatis oblongisve retusis mucronulatisque costatis scabris, spicis erectis multifloris, ramis tetragonis.

Citharexylum ellipticum, *Sesse et Mocinno MSS.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia pollicaria, subsessilia, scabra, apice retusa cum mucronulo. *Spicæ* erectæ, 3-unciales.

11. C. *incanum*, inerme; foliis ovatis serratis subtùs ramulisque pubescentibus, spicis erectis, dentibus calycinis inæqualibus.

Citharexylum incanum, *Sesse et Mocinno MSS.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia ovata, acutiuscula, serrata, rarò subintegerrima, subtùs copiosè cinereo-pubescentia, basi attenuata. *Petioli* semunciales. *Spicæ* erectæ, sesqui v. tripollicares. *Calyces* 5-dentati: *dentibus* recurvis, inæqualibus; *antico* et *postico* majoribus.

12. C. *scabrum*, inerme; foliis ellipticis mucronulatis subtùs cinereo-tomentosis scabris, spicis erectis secundis, dentibus calycinis inæqualibus.

Citharexylum scabrum, *Sesse et Mocinno MSS.*

Hab. in Mexico. *Sesse et Mocinno.* ♄. (V. s. sp. in Herb. Lamb.)

Folia 2–3-uncialia, suprà scabra, subtùs densè cinereo-pubescentia, basi acuta. *Petioli* semunciales. *Spicæ* erectæ, 6-pollicares. *Calyces* 5-dentati: *dentibus* recurvis: *antico* productiore.

On the adaptation of the Fly-wheel and Pulley of the Turning-lathe to a given Length of Band. By Mr EDWARD SANG, Teacher of Mathematics, Edinburgh.

EVERY one accustomed to the use of the turning-lathe, is aware of the necessity for frequent changes in the velocity of the spindle. Each different material that is wrought,—each diameter of the various parts of the work,—and almost every different tool that is employed to cut it,—requires a particular velocity. The most ready means for effecting these changes, is to cut two series of grooves, one series in the edge of the fly-wheel, and a corresponding one in that of the pulley; and to have these grooves so arranged that the same band may fit upon any one pair of them.

When the band is *crossed,* the formation of these grooves is attended with no difficulty; for, while the sum of the diameters of the wheel and pulley is kept the same, the length of the band is unaltered. We have thus only to increase the diameter of the pulley as much as we diminish that of the fly-wheel; and it may be noticed, that the same band will pass over any pair of grooves formed agreeably to this rule, whatever be the thickness of that band.

When the band is *plain,* the arrangement of the grooves is much more troublesome, and needs the aid of calculations too long and too intricate to be performed by the generality of those who are engaged in the construction of turning-lathes; on this account, the adjustment is most frequently effected after repeated trials. My object is to render these requisite calculations so simple as to offer no serious difficulty to practical men; for this end, I will avoid every appeal to the complex operations of trigonometry, and will use such expressions only as may be intelligible in the workshop.

By no artifice can the actual performance of the calculations be avoided; but, by entering the results in tables, the labour of one person may be made available to others. A complete able, to answer our present purpose, one which would only give to the artist the trouble of inspection, would need to exhibit the lengths of the bands which would pass over all pulleys and wheels placed at various distances from each other. The inconvenience attending all tables of triple entry, and the excessive labour of constructing such a one, forbid the hope of ever seeing it completed. Some mode must be devised which may abridge the labour of the calculator, without adding too much to that of the inspector; and I have now to explain those considerations which may be supposed to have led me to that abridgment which I have used: among these will be found all the principles which are necessary to the rightly understanding and using of the subjoined Table.

When we have a table of the lengths of bands fitting on various wheels and pulleys, placed at one fixed distance from each other, it is not very difficult thence to compute the length of band for any lathe whose axes are placed at a different distance. Conceive all the parts of the lathe last mentioned to be altered in proportion, until the distance between its axes is equal to the distance between the axes of the former, and its parts will be found among those entered in the table. The length of band found for this size has only to be altered in the proper ratio, to give the length wanted, and the same might be said of any other dimension.

Let the diameters of the wheel and pulley be equally increased: a little reflection will satisfy any one that the length of the band, the circumference of the wheel, and the circumference of the pulley will, all three, be equally increased; and that thus, as long as the difference between the diameters of the wheel and pulley is kept the same, the excess of the band above the circumference of the fly-wheel, as well as its excess above the circumference of the pulley, is also unchanged. Now it is an easy matter to compute the circumference of a wheel when its diameter is known; so that we require only a table of the excesses of the band above the circumference of the pulley, and above the circumference of the fly-wheel, corresponding to each difference between the diameters of these wheels.

A table of these excesses, in the formation of which I took every precaution to insure accuracy, is subjoined. The first column contains the differences between the diameters of the fly-wheel and pulley, estimated in decimal parts of the distance between their axes, which is, throughout, regarded as the *unit.* In the second column, are inserted the corresponding excesses of the length of the band above that of the circumference of the pulley; these excesses being, for the sake of interpolation, accompanied by their differences. And the third column exhibits the excesses of the length of the band above the circumference of the fly-wheel, with their differences. The numbers in the first and second columns go on increasing, but those in the third column decrease.

All the dimensions of any turning-lathe must be divided by the number which expresses the distance between the axes, before any of them can be sought for in this table; and the results obtained from the table must again be multiplied by the number formerly used as a divisor, in order to obtain the quantities sought for. But this calculation may be avoided, by forming a scale of the tenth, hundredth and thousandth parts of the distance between the axes, and by using this scale in all the measurements. The latter method will, in all probability, be found the most convenient. As examples of the use of the Table, I will propose two questions.

I. On the pulley of a turning-lathe are already two grooves, one of 2.4, and the other of 5.0 inches diameter. The centre of the fly-wheel is distant 30 inches from that of the pulley, and the larger groove to be made on the fly is 25 inches in diameter. Required the diameter of the other groove to be made on the wheel?

Dividing all these dimensions by 30, we obtain unit for the distance between the axes, which is the distance assumed in the table; 0.08 for the diameter of the lesser, 0.1666 for that of the greater groove on the pulley, and 0.833 for that of the greater groove on the fly-wheel.

These numbers are just what would have been found on taking the dimensions with the scale above described.

In order to find the length of the band, we take the difference between 0.8333 and 0.08, which is 0.75333, and enter, with this number, the first column of the table. The nearest number which we can find is 0.75, opposite to which, in the second column, is found 3.32044. To correct this for the remaining figures 333, we multiply by these the tabular difference 1958, cutting off as many figures from the right of the product as there are figures in the multiplier: this done, we obtain the correction 653, which, added to 3.32044, gives 3.32697 for the correct excess of the band above the circumference of the pulley. But, if we multiply 3.1415926 by .08, the diameter of the pulley, we have .25133 for its circumference; so that the whole length of the band, the sum of 3.32697 and .25133, must be 3.57830.

In order to compute the size of the new groove to be cut in the wheel, we observe, that, as the band now passes over a pulley whose diameter is 0.16666, its excess above the circumference of that pulley, which circumference is .52360, is 3.05470. Entering the second column of the table in search of this number, and taking that which is immediately *less*, we find 3.05195, which has 0.61 opposite to it in the first column; to obtain the correction for this number, we divide 275, the error, by 1884, the tabular difference, affixing as many ciphers to 275 as we wish to obtain new decimal places: the result of this division is 146, whence the true difference between the diameters of the fly-wheel and pulley is 0.61146; but the diameter of the pulley is 0.16667, wherefore that of the fly-wheel is 0.77813.

These two results, multiplied by 30, give, for the length of the band, 107.349 inches; for the diameter of the new groove, 23.344 inches.

II. The distance between the axes of a turning-lathe being 32 inches; and two grooves on the fly-wheel having 38 and 34 inches for their diameters: the lesser groove on the pulley is to be 3 inches in diameter; required the size of the other?

Dividing all the dimensions by 32, we obtain, for the diameters of the wheels 1.1875 and 1.0625, and for that of the lesser groove on the pulley .09375.

Entering the first column of the table for 1.09375, which is the difference between the diameters of the first pair of grooves, we find in the third column, opposite 1.09, the number 0.59297: To correct for the remaining figures, multiply 992, the tabular difference, by 375, and cut off three places; these operations give 372, which has to be *subtracted* from 0.59297, because the numbers in the third column grow less. The true excess of the band above the circumference of the wheel, is thus 0.58925. But the diameter of the wheel is 1.1875, therefore its circumference is 3.73064, and the whole length of the band 4.31989.

The circumference of the second groove on the fly-wheel is 3.33794, wherefore the excess of the band above that circumference is 0.98195. Entering the third column for this number, and taking the one immediately *greater*, we find, opposite to 0.98809, 0.73 in the first column. Dividing the error 614 by 1195, the tabular difference, we obtain 514, which, annexed to 0.73, gives 0.73514 for the true difference between the diameters. But the diameter of the wheel is 1.0625; wherefore that of the pulley is .32736.

These results, multiplied by 32, give,

For the length of the Band,............138.2365 inches.
For the diameter of the New Groove, 10.4755 inches.

If it be wished to allow for the thickness of the band, we have only to *add* to the calculated lengths, the circumference of a circle which has the thickness of the band for its diameter: the diameters of the grooves will be in no way affected by it.

With regard to the accuracy of the calculations, it may be mentioned, that there is no probability of an error of the thousandth part of an inch in any of the diameters. To this degree of exactness few will pretend to work.

Difference of Diameters.	Excess of the length of the Band above the circumference of the Pulley.		Excess of the length of Band above circumference of Fly-wheel.	
0.00	2.00000	1573	2.00000	1568
0.01	2.01573	1579	1.98432	1564
0.02	2.03152	1583	1.96868	1558
0.03	2.04735	1588	1.95310	1553
0.04	2.06323	1593	1.93757	1548
0.05	2.07916	1599	1.92209	1544
0.06	2.09515	1603	1.90665	1538
0.07	2.11118	1608	1.89127	1533
0.08	2.12726	1614	1.87594	1529
0.09	2.14340	1618	1.86065	1523
0.10	2.15958	1623	1.84542	1518
0.11	2.17581	1629	1.83024	1513
0. 2	2.19210	1633	1.81511	1509
0.13	2.20843	1638	1.80002	1503
0.14	2.22481	1644	1.74899	1498
0.15	2.24125	1648	1.77001	1493
0.16	2.25773	1653	1.75508	1489
0.17	2.27426	1659	1.74019	1483
0.18	2.29085	1663	1.72536	1478
0.19	2.30748	1669	1.71058	1473
0.20	2.32417	1673	1.69585	1468
0.21	2.34090	1679	1.68117	1463
0.22	2.35769	1683	1.66654	1458
0.23	2.37452	1689	1.65196	1453
0.24	2.39141	1694	1.63743	1448
0.25	2.40835	1698	1.62295	1443
0.26	2.42533	1704	1.60852	1438
0.27	2.44237	1709	1.59414	1433
0.28	2.45946	1713	1.57981	1428
0.29	2.47659	1719	1.56553	1423
0.30	2.49378	1724	1.55130	1417
0.31	2.51102	1729	1.53713	1413
0.32	2.52831	1734	1.52300	1407
0.33	2.54565	1739	1.50893	1403
0.34	2.56304	1744	1.49490	1397
0.35	2.58048	1749	1.48093	1393
0.36	2.59797	1755	1.46700	1387
0.37	2.61552	1759	1.45313	1382
0.38	2.63311	1765	1.43931	1377
0.39	2.65076	1769	1.42554	1372
0.40	2.66845	1775	1.41182	1367
0.41	2.68620	1780	1.39815	1362
0.42	2.70400	1785	1.38453	1357
0.43	2.72185	1790	1.37096	1351
0.44	2.73975	1795	1.35745	1347

Differences of Diameters.	Excess of the length of the Band above the circumference of Pulley		Excess of the length of Band above circumference of Fly-wheel.	
0.45	2.75770	1800	1.34398	1341
0.46	2.77570	1806	1.33057	1336
0.47	2.79376	1810	1.31721	1331
0.48	2.81186	1816	1.30390	1326
0.49	2.83002	1821	1.29064	1321
0.50	2.84823	1826	1.27743	1315
0.51	2.86649	1831	1.26428	1310
0.52	2.88480	1837	1.25118	1306
0.53	2.90317	1841	1.23812	1300
0.54	2.92158	1847	1.22512	1294
0.55	2.94005	1852	1.21218	1290
0.56	2.95857	1857	1.19928	1284
0.57	2.97714	1863	1.18644	1280
0.58	2.99577	1867	1.17364	1274
0.59	3.01444	1873	1.16090	1268
0.60	3.03317	1878	1.14822	1264
0.61	3.05195	1884	1.13558	1258
0.62	3.07079	1888	1.12300	1253
0.63	3.08967	1894	1.11047	1248
0.64	3.10861	1899	1.09799	1242
0.65	3.12760	1905	1.08557	1237
0.66	3.14665	1910	1.07320	1232
0.67	3.16575	1915	1.06088	1227
0.68	5.18490	1920	1.04861	1221
0.69	3.20410	1926	1.03640	1216
0.70	3.22336	1931	1.02424	1210
0.71	3.24267	1936	1.01214	1206
0.72	3.26203	1942	1.00008	1199
0.73	3.28145	1947	0.98809	1195
0.74	3.30092	1952	0.97614	1189
0.75	3.32044	1958	0.96425	1184
0.76	3.34002	1964	0.95241	1178
0.77	3.35966	1968	0.94063	1173
0.78	3.37934	1974	0.92890	1167
0.79	3.39908	1980	0.91723	1162
0.80	3.41888	1985	0.90561	1157
0.81	3.43873	1991	0.89404	1151
0.82	3.45864	1996	0.88253	1146
0.83	3.47860	2001	0.87107	1140
0.84	3.49861	2007	0.85967	1134
0.85	3.51868	2013	0.84833	1129
6.86	3.53881	2018	0.83704	1124
0.87	3.55899	2023	0.82580	1118
0.88	3.57922	2029	0.81462	1112
0.89	3.59951	2035	0.80350	1107

Differences of Diameters.	Excess of the length of the Band above the circumference of Pulley.		Excess of the length of Band above circumference of Fly-wheel.	
0.90	3.61986	2041	0.79243	1101
0.91	3.64027	2046	0.78142	1096
0.92	3.66073	2051	0.77046	1090
0.93	3.68124	2058	0.75956	1089
0.94	3.70182	2062	0.74872	1071
0.95	3.72244	2069	0.73793	1073
0.96	3.74313	2074	0.72720	1067
0.97	3.76387	2080	0.71653	1062
0.98	3.78467	2086	0.70591	1056
0.99	3.80553	2092	0.69535	1050
1.00	3.82645	2097	0.68485	1044
1.01	3.84742	2103	0.67441	1038
1.02	3.86845	2109	0.66403	1033
1.03	3.88954	2115	0.65370	1027
1.04	3.91069	2120	0.64343	1021
1.05	3.93189	2127	0.63322	1015
1.06	3.95316	2132	0.62307	1010
1.07	3.97448	2138	0.61297	1003
1.08	3.99586	2144	0.60294	997
1.09	4.01730	2151	0.59297	992
1.10	4.03881	2156	0.58305	985
1.11	4.06037	2162	0.57320	979
1.12	4.08199	2168	0.56341	974
1.13	4.10367	2174	0.55367	967
1.14	4.12541	2181	0.54400	961
1.15	4.14722	2186	0.53439	956
1.16	4.16908	2193	0.52483	949
1.17	4.19101	2199	0.51534	942
1.18	4.21300	2205	0.50592	937
1.19	4.23505	2211	0.49655	930
1.20	4.25716	2217	0.48725	925
1.21	4.27933	2224	0.47800	917
1.22	4.30157	2230	0.46883	912
1.23	4.32387	2236	0.45971	905
1.24	4.34623	2243	0.45066	899
1.25	4.36866	2249	0.44167	893
1.26	4.39115	2256	0.43274	886
1.27	4.41371	2262	0.42388	879
1.28	4.43633	2268	0.41509	873
1.29	4.45901	2275	0.40636	867
1.30	4.48176	2282	0.39769	860
1.31	4.50458	2288	0.38909	853
1.32	4.52746	2295	0.38056	847
1.33	4.55041	2302	0.37209	839
1.34	4.57343	2308	0.36370	834

Differences of Diameters.	Excess of the length of the Band above the circumference of Pulley.		Excess of the length of the Band above the circumferenee of Fly-wheel.	
1.35	4.59651	2315	0.35536	826
1.36	4.61966	2322	0.34710	820
1.37	4.64288	2329	0.33890	813
1.38	4.66617	2336	0.33077	805
1.39	4.68953	2343	0.32272	799
1.40	4.71296	2349	0.31473	792
1.41	4.73645	2357	0.30681	785
1.42	4.76002	2364	0.29896	778
1.43	4.78366	2371	0.29118	770
1.44	4.80737	2378	0.28348	764
1.45	4.83115	2386	0.27584	756
1.46	4.85501	2392	0.26828	749
1.47	4.87893	2401	0.26079	741
1.48	4.90294	2407	0.25338	734
1.49	4.92701	2415	0.24604	727
1.50	4.95116	2423	0.23877	719
1.51	4.97539	2430	0.23158	711
1.52	4.99969	2438	0.22447	703
1.53	5.02407	2446	0.21744	696
1.54	5.04853	2454	0.21048	688
1.55	5.07307	2461	0.20360	680
1.56	5.09768	2469	0.19680	673
1.57	5.12237	2478	0.19007	664
1.58	5.14715	2486	0.18343	656
1.59	5.17201	2494	0.17687	647
1.60	5.19695	2502	0.17040	639
1.61	5.22197	2511	0.16401	631
1.62	5.24708	2519	0.15770	623
1.63	5.27227	2528	0.15147	613
1.64	5.29755	2536	0.14534	605
1.65	5.32291	2546	0.13929	597
1.56	5.34837	2554	0.13332	587
1.67	5.37391	2564	0.12745	578
1.68	5.39955	2572	0.12167	569
1.69	5.42527	2582	0.11598	559
1.70	5.45109	2592	0.11039	550
1.71	5.47701	2601	0.10489	541
1.72	5.50302	2611	0.09948	530
1.73	5.52913	2621	0,09418	521
1.74	5.55534	2631	0.08897	510
1.75	5.58165	2642	0.08387	501
1.76	5.60807	2652	0.07886	489
1.77	5.63459	2662	0.07397	479
1.78	5.66121	2674	0.06918	468
1.79	5.68795	2685	0.06450	407

Differences of Diameters.	Excess of the length of Band above circumference of Pulley.		Excess of the length of Band above circumference of Fly-wheel.	
1.80	5.71480	2696	0.05993	445
1.81	5.74176	2708	0.05548	434
1.82	5.76884	2720	0.05114	421
1.83	5.79604	2733	0.04693	409
1.84	5.82337	2745	0.04284	396
1.85	5.85082	2759	0.03888	383
1.86	5.87841	2772	0.03505	370
1.87	5.90613	2786	0.03135	355
1.88	5.93399	2801	0.02780	341
1.89	5.96200	2816	0.02439	326
1.90	5.99016	2832	0.02113	309
1.91	6.01848	2849	0.01804	292
1.92	6.04697	2867	0.01512	275
1.93	6.07564	2886	0.01237	256
1.94	6.10450	2907	0.00981	235
1.95	6.13357	2929	0.00746	212
1.96	6.16286	2954	0.00534	187
1.97	6.19240	2984	0.00347	158
1.98	6.22224	3020	0.00189	122
1.99	6.25244	3075	0.00067	67
2.00	6.28319		0.00000	

Having given an account sufficiently clear, as I hope, to be understood by all practical people, of the nature and uses of the preceding Table, I have now to exhibit to such as would examine the matter more deeply, the processes which were used in its formation.

Let w and p be the diameters of the wheel and pulley, d the difference between them, and θ the inclination of the free part of the band to the plane of the two axes.

Then, we have $\sin\theta = \frac{d}{2}$; and the length of each free part of the band $\sqrt{1 - \frac{d^2}{4}}$. But the length of that portion of the band in contact with the wheel, is $w\left(\frac{\pi}{2} + \theta\right)$, and of that in contact with the pulley, $p\left(\frac{\pi}{2} - \theta\right)$. The whole length of the band is thus $\sqrt{(4 - d^2)} + w\left(\frac{\pi}{2} + \theta\right) + p\left(\frac{\pi}{2} - \theta\right)$: which is equal either to

$$\sqrt{(4 - d^2)} + d\left(\frac{\pi}{2} + \theta\right) - p\pi\,;$$

or to $$\sqrt{(4-d^2)}-d\left(\frac{\pi}{2}-\theta\right)-w\pi.$$

Wherefore, the excess of the length of the band above the circumference of the pulley, is

$$\sqrt{(4-d^2)}+d\left(\frac{\pi}{2}+\theta\right),$$

and its excess above that of the fly-wheel, is

$$\sqrt{(4-d^2)}-d\left(\frac{\pi}{2}-\theta\right).$$

Each of these expressions is dependent only on the difference d, between the diameters w and p.

In the actual computation, we observe that $4-d^2=(2+d)(2-d)$; and also that $\delta\theta=\sec\theta.\delta.\sin\theta$ when $\delta.\sin\theta$ is very small. One example of the entire calculation I subjoin.

$d=1.77$; $\sin\theta=.885$, error 124.

Log sec 62° 15′ =	.33197	62°	= 1.0821041
Log 124	= 2.09342	15′	= 43633
	2.42539 =	Log corr. =	266
		θ	= 1.0864940
		$\frac{\pi}{2}$	= 1.5707963

$2+d = 3.77$

$2-d = .23$

$4-d^2 = .8671$

$866761 = .931^2$

18621	33900
1	18621
18622.8	152790
	148982
	3808
	3725
	83

$d(\frac{\pi}{2}+\theta)=\begin{cases}2.6572903\\ 1.7601032\\ .1860103\end{cases}$

$d(\frac{\pi}{2}-\theta)=\begin{cases}0.4843023\\ .3390116\\ 339012\end{cases}$

$d(\frac{\pi}{2}+\theta) = 4.7034038$

$\sqrt{(4-d^2)} = 0.9311820$

$d(\frac{\pi}{2}-\theta) = 0.8572151$

Excess of band above pulley = 5.6345858

Excess of band above wheel = 0.0739669

After this manner, I computed the excesses of the band, corresponding for a while to each tenth, then to each fifth, to each fourth, and to each alternate difference of diameter; narrowing the intervals as the rapid change of the differences required, until the last forty numbers were computed strictly. The somewhat irregular intervals that were thus left, I afterwards filled up by the method of differences, taking care to leave no chance of an error in the sixth, hardly indeed in the seventh decimal place. The numbers which I have given are only to five places, and may thus be relied on as true to the nearest hundred thousandth part of the distance between the centres; except, perhaps, in one or two instances, when the rejected figures were 50, 49, or 51, and when it was difficult to say whether the last figure of the five should be preserved, or increased by unit.

I need hardly observe, that when d is supposed to be negative, θ becomes so too, and that thus the two partial formulæ are but different cases of a single one. There are properly, then, not two tables, but, if the numbers in the third column be conceived to be written beginning at the last, and proceeding backwards to the top of the second column, and then returning down the second, while the numbers in the first column are made to run from -2.00 to $+2.00$, the whole of the results form one series.

If, in the lathe with crossed bands, w and p denote the diameters, s their sum, we have $\sin\theta = \frac{s}{2}$; the length of each free part of the band $\sqrt{\left(1 - \frac{s^2}{4}\right)}$: the length in contact with the wheel $w\left(\frac{\pi}{2} + \theta\right)$, and of that in contact with the pulley $w\left(\frac{\pi}{2} + \theta\right)$; wherefore the whole length of band is

$$\sqrt{(4 - s^2)} + s\left(\frac{\pi}{2} + \theta\right),$$

which is exactly the formula, changing s into d, for the numbers entered in the second column.

If, then, we enter the first column with the sum of the diameters of the wheel and pulley (plus twice the thickness of the band), the opposite number in the second column will give the length of the band when crossed.

On the Development of the Vascular System in the Fœtus of Vertebrated Animals. Part II. By Allen Thomson, M.D. late President of the Royal Medical Society. Communicated by the Author. (Concluded from p. 111.)

Development of the Respiratory Organs in the Ophidia, Chelonia and Sauria.

In proceeding to consider the development of the respiratory organs of the higher orders of reptiles, we pass from those animals which are aquatic, either during the whole or some period of their existence, to those which are entirely aërial during fœtal and adult life.

The ova of the serpents, turtles, and lizards, are deposited and become developed in the same medium in which the adult animal respires; but in these animals, as well as in birds and mammalia, a proper envelope for the fœtus or amnios is formed by the reflection of the serous layer of the germinal membrane *, and the fœtus is thus kept constantly immersed in a fluid till the period when it begins to inspire air into the lungs.

It is well known that the respiration of the fœtal lizard, like that of other animals, is first carried on by the distribution of the blood over the surface of the sac of the yolk. In the former part of this essay, it was stated that the observations of Dutrochet, Emmert, Hochstetter and Baer, had shown that the embryo of the lizard becomes developed on the surface of the yolk, and that the blood and vessels are first produced in the form of a network, on the surface of the area surrounding the fœtus. This network, like that in the ova of cartilaginous fishes, birds, and mammalia, is composed of the minute ramifications of the omphalo-mesenteric arteries, and of corresponding veins, which carry to the vena portæ the blood that has passed through the network. The sac of the yolk, over which the vascular network spreads itself more and more widely as development proceeds, is at first situated near the internal surface of the shell, or other covering of the ovum, and the blood contained in its vessels is arterialized by the transmission of oxygen from the air without.

* See Fig. 21 of amnios in birds. *n*.

After the first half of fœtal life has passed, the yolk sac is removed from the inside of the chorion, and its place is supplied by another vesicular membrane coming from the fœtus, which gradually expanding, entirely encompasses the fœtus, and on which the blood is now exposed, in order that it may undergo the necessary respiratory changes. The sac of the yolk still remains, however, covered by its network of vessels, which probably serve to absorb the substance of the yolk for the nourishment of the fœtus, or being now less exposed to the air, perform some subordinate part in respiration (Fig. 17, *x y*).

The vesicular membrane which supplies the place of the yolk sac as a respiratory organ, is the same part in a more expanded condition, which becomes developed in the batrachian tribes at the commencement of their aërial existence. According to the observations of the authors already quoted, the allantois of the Lacerta agilis appears, at the earliest period at which it has been seen, in the form of a small vesicle hanging from the lower part of the abdomen, projecting like a process from the cloacal part of the intestine, and resembling in its form and position the urinary bladder (See Fig. 19, Part I.). At this time the allantois is covered by a network of minute vessels, which become more obvious as the vesicle expands. Continuing to enlarge, it insinuates itself between the fœtus and the covering of the ovum (See Diagram, Fig. 18), and its farther progress outwards being impeded, it expands laterally till it envelopes the fœtus in its amnios, and the yolk, with a double layer of a vascular membrane (Fig. 17, *z v'*). The vessels distributed on this membrane are the umbilical arteries and veins; the outermost layer is the most vascular, and is applied close to the inner side of the envelope of the egg, where it receives the full influence of the air transmitted to it from without. The allantois continues to act as a respiratory organ till the fœtus breaks the shell, or tears the covering of the egg, and comes out fitted for receiving air into its lungs, and respiring solely by these organs. The greater part of the allantois remains in the egg, in the Lacerta agilis, and the urinary bladder of the adult is formed by a part at its root separated from it by the urachus, on each side of which the umbilical vessels previously proceeded to gain the expanded part of the vesicle.

The respiration, therefore, of the fœtus of the lizard, as well as that of all oviparous animals higher in the scale, is entirely performed by the two membranes to which we have just alluded, viz. the sac of the yolk and the prolongation of the urinary bladder or allantois *.

Many lizards and serpents, however, are not truly oviparous, but retain their ova till the development of the fœtus has proceeded some way, in general till the allantois becomes sufficiently expanded to be fitted to carry on respiration; and some serpents, such as the Coluber berus, are almost entirely ovo-viviparous. In this last it is curious to observe that the arterialization of the fœtal blood is effected, though by a simpler apparatus, in nearly the same manner as that of mammalia, or truly viviparous animals. The allantois of the viper, after expanding so as to enclose the fœtus and yolk, comes into contact with a vascular lining of the oviduct, and is closely united with it, so that the venous blood of the fœtus is exposed to the influence of the oxygenized arterial blood of the parent.

It is an interesting fact also, that in some of the Testudines, the allantois, or at least a part of it, remains permanently in the adult, and that the umbilical vein continues as in the batrachia to carry off its blood to the liver. In the Testudo orbicularis, according to Townson, water is introduced into this sac, and it appears not improbable that the large urinary bladder, or permanent allantois of the turtles and of some serpents, serves as an auxiliary in the function of respiration during the whole of life †.

Although respiration by means of gills is rendered unnecessary, by the perfect state of the allantois in these reptiles, yet it appears, from some late observations, that at a period of the development of these, as well as of all the more perfect animals which have been examined, corresponding with that at which the branchiæ of fishes and batrachia begin to be formed, the

* The connexion of the sac of the yolk with the intestine has been demonstrated also in the Coluber natrix by Bojanus, Journal de Physique, 1829; and Dutrochet has shown very clearly the mode of development of the allantoid in the viper, in the Memoires de la Societé Medicale d'Emulation, tom. viii. Several preparations in the College of Surgeons' Museum, London, illustrate these facts extremely well, and some the sac of the yolk of the turtle.

† See Carus' Compar. Anat., vol. ii. p. 249.

existence of gills in a rudimentary state, is indicated by the structure of the pharynx and surrounding parts. In the early periods of development, the distribution of the arteries especially, which take their origin from the bulb of the aorta, bears a striking resemblance to the primitive simple state in which these vessels have been observed to exist in fishes and batrachia before their gills are formed. In the embryo of the Lacerta agilis, while the cavities of the heart are yet single, Baer has observed that the aorta is divided into five pairs of vascular arches, which, after winding round the sides of the pharynx, reunite with one another above it to form the descending aorta. Baer and Rathke have also observed, that while these subdivisions of the aorta—which may very properly be called branchial arteries—exist, the sides of the pharynx are penetrated by transverse fissures, on each side of which runs one of the vessels rising from the bulb of the aorta. The same appearances have been observed by Baer in the fœtus of the Coluber natrix, at a corresponding period of its development.

In these animals, however, the transverse plates of the neck, and the branchial arteries passing along them, do not undergo farther subdivision, or become more fully developed, like the gills of fishes or batrachia; on the contrary, the plates are gradually incorporated with the parietes of the pharynx, the apertures are entirely closed, and the vascular arches are converted, by the obliteration of some parts and the enlargement of others, into the arteries, which, in the adult animal, take their origin from the right and left ventricles or cells of the heart.

Unfortunately, the manner in which the farther development of these parts takes place has not been observed, owing to the difficulty of procuring the ova of the saurian and ophidian reptiles at many different stages of fœtal life. From the many varieties in the distribution of the arteries rising from the heart in these reptiles, it appears probable that this would prove a very interesting subject for investigation; and it may be remarked, that no animals are better suited for observation, from the length of time that the blood continues to circulate in the fœtus after it has been taken from the ovum.

Two of the branchial arches appear to remain permanent, in order to form the right and left roots of the aorta in the adult lizard and tortoise. The anterior parts only of three other pairs of branchial arches also remain to convey blood into the carotid, subclavian and pulmonary arteries (See Fig. 19).

The development of the lungs has been little attended to in the higher reptiles. In lizards and tortoises the lungs are double, and the pulmonary arteries are derived from the pulmonary arch on each side (See Fig. 19). In serpents, on the other hand, the lungs, as well as the pulmonary artery, are generally single; but in the Anguis fragilis, in the adult of which the lungs are double, Rathke has observed, that in the fœtus they are at first single; they consist of a mass of dense gelatinous substance, in which a cavity is gradually formed; in this animal the left is gradually separated from the right lung in the progress of development, and the cavities of the two lungs continue to communicate freely with one another for some time.

Development of the Respiratory Organs in Birds.

For the development of the ova of birds, the application of external heat, as well as the direct agency of air, is required, and a respiratory change of the blood of the fœtus, comparatively as extensive as that in the adult bird, seems to be necessary. This change is produced by means of the same membranes, viz. the sac of the yolk and allantois, as those on which the blood of the fœtal lizard is exposed, and though these parts are considerably more developed in birds, their relations, as well as the mode in which they are supplied with vessels, are nearly the same as in the higher reptiles. But the facts relative to the structure of these membranes appear to be so well known, as to render it unnecessary for me to enter into any detailed account of them.

While the respiration of the fœtal bird is almost entirely carried on by the membranes of the yolk and allantois, the structure of the parietes of the neck and pharynx, as well as of the adjoining arteries, exhibits certain traces of branchiæ similar to those already alluded to in the embryo of the lizard. These appearances were first discovered by Rathke, and an account of them was published by him in the Isis, in 1825; it is since this time that the observations of this author have been extended, and the same appearances discovered in the lizards, serpents, and mammalia by himself, and by Huschke, Baer and others; by which a series of analogies of the most interesting nature has been established between air-breathing animals, and those which are aquatic during the whole or some part of their existence *.

From the manner in which the rudimentary intestinal canal is formed, it has been shewn that the anterior and posterior parts of the intestine constitute at first two shut sacs, into which the only entrance is by a large opening in the middle between them, by which they communicate with the sac of the yolk. Neither mouth nor anus, therefore, at first exist; but both these apertures are afterwards formed by a wasting away or absorption of the substance of the germinal membrane, at the two extremities of the rudimentary intestine. The opening of the mouth (Fig. 21, *e*) appears towards the end of the second day of incubation, some days before that of the anus is perforated. The mouth, or anterior opening into the intestinal canal †, has at first the appearance of a transverse slit, or cleft, on the lower part of the head. On the third day, the part of the intestine into which this opening leads becomes wider anteriorly, and assumes the form of a cone, the apex of which is directed towards the tail of the embryo. The walls of this cavity, which corresponds in many respects with the branchial cavity of cartilaginous fishes, and with part of what is afterwards converted into the pharynx of the bird, become thicker and of a firmer consistence at the same period. Towards the end of the third day six clefts, or transverse slits, make their appearance behind the mouth, three on each side of the intestine. The foremost pair of these clefts appears first, and the second and third after it gradually. The wall of the pharyngeal cavity projects slightly at the parts between the clefts on each side; it is here of a firmer consistence than elsewhere, and has the appearance of being formed of transverse bands, united anteriorly on the mesial line, like the branchial

* See the Memoirs of Rathke in the Répert. Génér. d'Anat. et de Physiol., tom. vii., in the Edinburgh Medical and Surgical Journal, 1830; and in the Isis, 1825, No. 6, and 1828, No. 1; those of Huschke in the Isis, 1827, No. 1, and 1828, No. 2; and those of Baer in Meckel's Archiv. vol. ii., No. 4; and in Breschet's Repertoire, 1829; also Baer, de ovi mammalium et hominis engesi Epistola.

† The opening alluded to can scarcely with correctness be called the mouth at this period, this cavity being afterwards formed before it, by the growth of the superior and inferior maxillæ.

hoops of the fœtus of the batrachia or of fishes, before the leaflets of the gills are formed.

The aorta, in the mean time, begins to divide itself into vessels which correspond with branchial vascular arches. At the end of the second day, the aorta rising from the bulb behind the pharyngeal portion of the intestine, runs forward along the middle and lower part of this cavity, till it approaches the opening of the mouth; here it divides into two branches, which separating from one another, proceed round the sides of the intestine close to the angle of the opening of the mouth, and join again near the vertebral column to form the descending aorta. During the first half of the third day, a second pair of vascu ar arches is formed behind the first, which encompasses the pharynx in a similar manner; and towards the end of the third day, two other pairs of vascular arches being formed, the anterior part of the intestine is surrounded by four pairs of vascular arches, rising successively from the aorta on the lower side, and joining into the two roots of the aorta on the upper side of the intestine. On the third day, according to Baer, the foremost of these pairs of vessels which may be called branchial, the one first produced is the largest, and makes the widest sweep; the fourth, or posterior, is very small and scarcely perceptible.

Each of these vascular arches, in winding round the side of the pharynx, passes along one of the parts which correspond to the branchial hoops; so that each of the three clefts or apertures on each side of the pharynx is situated between two of the vascular arches. At the end of the third and beginning of the fourth day, all the arches, and more especially the fourth, become larger and fuller of blood, and, at the same time, the branchial hoops become thicker, and the apertures between them wider; but in the course of this day the first vascular arch, having attained its full size, soon begins to be less visible, both on account of its own diminution or partial obliteration, and of the enlargement and increased opacity of the branchial hoop along which it passes. Towards the end of the fourth day, this arch is wholly obliterated, and no longer allows of the passage of blood into the root of the descending aorta. A vessel proceeding to the head and neighbouring parts, which afterwards becomes the carotid, has, however, taken its origin from its most anterior part, into which the blood is still propelled from the bulb of the aorta through the communicating vessel of the second arch (Fig. 30).

While the first pair of vascular arches is obliterated, a fifth pair is formed behind the four which previously existed, proceeding in the same manner from the ascending to the descending aorta. At the same time, the first branchial aperture, situated between the first and second vascular arches, is gradually closed, and a fourth appears between the fourth and fifth arches. Thus there exist in the neck of the embryo of the chick five vascular arches and four branchial clefts, corresponding with the appearances in the neck of the salamander and fish, and the analogy between these animals and the fœtal chick before referred to becomes apparent (Fig. 20, *m. o*). Rathke has observed, that the distribution of the arteries, as well as the structure of the branchial hoops, in the fœtus of the Blennius vivip., resemble almost exactly those in the chick on the fourth and fifth days. Baer remarks, that he has never seen more than four vascular arches co-existent in the embryo of the chick. In the embryo of the duck of four days and a half, I have observed four apertures co-existing, and four vascular arches very apparent; from which it appears probable that a fifth also existed, though not easily seen from the small quantity of blood it contained.

On the fourth day, the second arch also becomes less, and on the fifth day is wholly obliterated, while the third and fourth now become stronger. Towards the end of the fifth day (See Fig. 22, *o*), the three remaining clefts on each side of the pharynx become gradually less perceptible, and are soon closed by the union of the integuments on each side of the cleft. The anterior clefts remain open longer than the posterior, and while they are closed on the outside, they are still visible on the inside of the pharynx, in the form of small cavities opening into it (Fig. 23). The third arch, now the most anterior of those remaining, forms the brachial arteries. The vessels of the anterior extremities spring from the place where the third vascular arch joins the root of the aorta (Fig. 30, *w*). They may be perceived with ease on the eighth day, and after this period, the branch (*w*) by which the third arch joins the fourth in the root of the aorta shrinks and gradually becomes smaller, till it entirely disappears before the 13th or 14th day; at which time the whole of the blood sent through the anterior branches from the bulb of the aorta, is carried to the carotid and brachial arteries exclusively, and no longer reaches the root of the aorta. There now remain, therefore, only four vascular arches, viz. the fourth and fifth pairs (*p r*), from which the proper trunks of the aorta and pulmonary arteries are formed.

It has already been shewn, that, on the fifth day, the septum of the ventricles is completed, and separates entirely the right from the left arterial cavity of the heart. These cavities during their contraction propel their contents into the bulb of the aorta, which remains a single cavity for some time after the ventricles are distinct. Towards the end of the fifth or beginning of the sixth day, according to Baer, the bulb of the aorta becomes flattened, and the opposite sides of the tube adhere together along the central part, so as to separate it into two vessels, situated side by side, and enclosed within the same sheath. The vessel situated on the left side, becoming considerably shorter, afterwards forms the root of the pulmonary arteries; that on the right side forms the commencement of the aorta. As these vessels join their respective ventricles, they appear to cross, or to be twisted round one another.

As development proceeds, the root of the aorta is more completely separated from that of the pulmonary artery, and a remarkable change, at the same time, takes place in the direction of the blood through the vessels into which they lead. The blood, propelled by the contraction of the left ventricle through the aortic root (R), instead of going as before into all the vascular branches rising on the fore part of the neck, now passes only into the fourth vascular arch on the right side, and the two arteriæ innominatæ which arise from it (*t, u, r, s*); while the blood from the right ventricle is sent through the pulmonary root (P) exclusively into the fourth arch on the left side, and the two fifth or posterior arches (*p. p*) *. The fourth arch now becomes gradually larger, and becomes the freest mode of communication between the ascending and descending aortæ; it forms, in fact, the proper arch of the aorta. In the mean time,

* Baer explains this change by supposing that, when the roots of the pulmonary artery and aorta are separated, the blood acquires a new direction, and is thus driven into their respective vessels.

the fifth arch on the left side becomes less, gradually carries a smaller quantity of blood, and soon after the separation of the aortic and pulmonary roots is entirely obliterated. Three arches only, therefore, now remain, viz. the fourth on the right side or the trunk of the aorta itself, its corresponding arch on the left side, and the fifth on the right, the two last of which soon after give rise to the pulmonary arteries.

On the fifth and sixth days, the parietes of the pharyngeal or branchial cavity of the chick also undergo a transformation. According to Rathke, the part intervening between the mouth and the first pair of branchial apertures becomes thicker and firmer, and is divided by a transverse groove into two portions (Figs. 24 and 25.) The anterior of these (ε), bulging out at the sides, forms by its farther development the inferior maxilla; the posterior (λ), smooth and projecting less, gives rise to a pendulous fold which overlaps the first branchial slit, and which this author compares to the operculum of fishes *. When the branchial apertures have closed, the neck begins to become much longer and narrower in proportion to the head and body of the chick. The part immediately before the opercular covering, or between it and the maxilla infer., seems especially to be expanded in producing this elongation; while the opercular covering itself, and the part in which the posterior branchial apertures were situated, remain adhering to the fore part of the thorax. At the same time, the carotid arteries are lengthened out, and the other vascular arches in the fore part of the thorax become straighter, and assume more nearly the position they afterwards have in the adult bird (Fig. 31, *t*, *u*, *r*, *s*, *p*).

While these changes take place in the branchial hoops and vascular arches, the Lungs begin to be formed. The rudiments of these organs may be perceived as early as on the fourth day. The researches of Rathke † have shown that the lungs and air

* From the drawings which Rathke has given of the fœtal fish, there can be no doubt of the correctness of this comparison; but he seems to have omitted to observe, that, before the formation of the opercular body in the fœtus of the chick, the most anterior branchial aperture is closed.

† Sur le Developpement des Organes Respiratoires, in Breschet's Repertoire d'Anat. et de Physiol.; and translated in Edinburgh Medical and Surgical Journal, Jan. 1830.

passages are developed on the anterior side of the œsophagus, but they render it improbable that these organs are produced, as some have supposed, like a process or diverticulum of the intestinal canal. According to Rathke, the lungs are formed a short time before the trachea or bronchi; they consist, on the fourth and fifth days, of two small mucus-like masses (Fig. 26, A. B.) situated above the pericardium, and before the stomach. The trachea and bronchi (*l′*) appear at first like a thickening of the lower side of the œsophagus; the trachea is at first so short, proportionally to the bronchi, as to be scarcely perceptible. On the fifth day these parts are increased in size (Fig. 27), and have become more distinct, but they are as yet quite solid, and without any internal cavity. On the sixth day, the trachea is elongated proportionally to the bronchi, and a cavity is evident in the interior of the lungs. This cavity, however, is confined to the posterior and lower part of the lungs only, and Rathke has shown that this part (Fig. 28, *l*) afterwards becomes the cellular part of the respiratory organs of the birds. The anterior part (L), corresponding to the bronchial part of the lung, still remains quite solid. On the seventh day, the cavity in the cellular part of the lung is increased, and the trachea and bronchi are become quite hollow; minute air-tubes radiating from the extremities of the bronchi, at the same time, appear in the anterior solid part. After this period the whole lung grows rapidly, and approaching the vertebral column and ribs, becomes firmly united to these parts. The bronchial part of the lung remains closely united with the air-sacs till the 12th day (Fig. 29), when the vesicular part begins to increase with great rapidity, and envelopes all the viscera of the chest and abdomen a few days before the chick comes out of the egg.

The communication of these air-sacs with the bones is not established till some days after the end of incubation.

Each of the lungs, shortly after its formation, receives an arterial branch from the pulmonary arches (the fourth left and the fifth right branchial arches), (Fig. 30, *p*). These branches gradually become larger as the lungs are developed; but as the blood which they carry to the lungs is returned to the left auricle by proper veins, the parts of the arches leading into the aorta behind the pulmonary arteries gradually become less. These communicating vessels (Figs. 29, 30 and 31, *p p' δ*), forming the ductûs botalli of the bird, still retain a considerable size, till the period when the inspiration of air into the lungs takes place, when the whole of the blood entering the pulmonary arches from the right ventricle, is carried into the pulmonary arteries, and the branches communicating with the aorta are entirely obliterated *.

Development of the Respiratory Organs in the Fœtus of Mammalia.

As the ova of mammiferous animals are entirely developed in the uterus, the blood of the fœtus is supplied with air entirely through the medium of the parent, and the respiratory change which it undergoes is comparatively much less perfect in these animals than in birds. During the earlier periods of fœtal development in the mammalia, vascular membranes exist, analogous to those which act as respiratory organs during the whole of fœtal life in birds; but these membranes seem to be capable of producing the changes of respiration during a short time only, and their place is soon supplied by another structure, by means of which the bloodvessels of the fœtus are brought into intimate contact with those in the uterus of the mother.

It has already been shown that the fœtus of mammalia, like that of other vertebrated animals, becomes developed on the surface of the yolk, and that, while the rudiments of the fœtal organs are forming, the yolk is gradually surrounded by the layers of the germinal membrane, upon which a vascular area similar to that in birds is produced. The fœtus of mammalia, like the chick in ovo, lies with its left side towards the yolk. The intestine of the fœtus necessarily communicates with the yolk-sac, as both these parts are formed by folds of the same layers; and the vascular network of the yolk is formed as in the chick, by the omphalo-mesenteric arteries and veins.

The yolk-sac differs very much in its relations in the different families of the order Mammalia †. In the common ruminating

* See Baer's Entwickelungsgeschichte der Thiere, and the Repertoire Générale, tom. viii.

† See Introduction to this Essay.—See Baer de Ovi Mammalium et Hominis genesi.—Cuvier and Dutrochet in Mémoires du Museum, vol. iii.

animals, such as the sheep or cow, and also in the pig and horse, the yolk ceases to increase at a very early period; the part by which it communicates with the intestine is lengthened out, and the sac of the yolk, collapsed and empty, remains hanging for some time from the funis of the umbilicus, attached by a long and narrow cord to a projecting fold of intestine (Fig. 32, *x y*). The yolk at this period has generally received the name of Umbilical Vesicle; it still retains a yellowish colour, a spongy granular consistence, and the ramifications of vessels are visible on it till it at length disappears.

In carnivorous animals the umbilical vesicle, or sac of the yolk, resembles, more than in any others that have been examined, the sac of the yolk in birds. In the cat it is filled with a substance of a dark yellow colour. In the progress of development, however, it comes to have the shape of a long narrow vesicle lying parallel to the long diameter of the fœtus, and fastened by its two pointed extremities to the chorion, or outer membrane of the ovum (Fig. 33, of the Dog).

In the ovum of the human species,* the yolk-sac, or umbilical vesicle, is very small and globular, and disappears shortly after the end of the second month. But in the rodentia, as in the rabbit or hare, the umbilical vesicle is highly developed, and the blood-vessels distributed on it comparatively numerous and large. At first this vesicle resembles much the yolk-sac of birds (Fig. 34); but in the later stages of development, it is expanded so as to form a vascular covering over nearly all the parts of the ovum.

The Allantoid Membrane, or expanded portion of the urinary bladder, becomes developed in the fœtus of mammalia, in the same manner as in that of lizards, serpents, and birds. The umbilical vessels are ramified on it, and for some time after its first appearance it preserves the same relations as in these animals.

In ruminating and pachydermatous animals in which the umbilical vesicle is small, the allantois is very highly developed.

and Emmert in Reil's Archiv., B. x. h. i.—Blumenbach and Carus' Comp. Anat.—Dutrochet in vol. viii. of the Mémoires de la Soc. Méd. d'Emulation; and Bojanus in Meckel's Archiv. B. iv., and in Nov. Act. Phys. Med. tom. x.

* See the description of the membranes in the human embryo, in the Traité d'Accouchemens by Velpeau. Paris, 1829. Vol. ii. p. 230.

In the horse, pig, cow and sheep, its growth is very rapid immediately after its first appearance; it fills the whole of the cornua of the uterus, or of the compartment which each ovum occupies (Fig. 32, *z z'*). It consists of two layers, the external being most vascular, and is filled with a transparent and sometimes gelatinous substance.

In the cat and dog, again, the allantois envelopes the fœtus in its amnios, and the yolk, much in the same way as in the eggs of birds (Fig. 33), leaving the yolk free on one side, however, during a considerable part of fœtal life.

In the Rodentia, the umbilical vesicle is so much developed, that it appears to have taken the place of the allantois; this latter membrane is proportionally much less extended; it retains its vesicular form for a considerable time, and is enclosed between the folds of the umbilical vesicle (Fig. 34).

The outer layer of the allantois, from its forming a lining to the envelope of the ovum, has been called Endochorion. The umbilical vessels are ramified principally on this part of the allantois, and being brought near into contact with the arterial vessels distributed on the lining of the uterus, the respiratory change of the blood in the umbilical arteries is thus for some time performed.

Very soon, however, after the allantois has expanded, so as to fill the cavity of the uterus, or of the different compartments occupied by the ova, and comes into contact with its parietes, the Placenta, or principal respiratory organ of the fœtal mammiferous animal begins to be formed. The structure of this part may be most easily examined in the ova of ruminating animals, as in the cow. In this animal, when the vascular or external layer of the allantois lines the chorion, the extremities of the umbilical vessels ramified on the allantois, leave that membrane at particular parts, and join the chorion. This latter membrane then becomes uneven at the places where these vessels join it; and as development proceeds, numerous little processes (Fig. 32, B) project from its external surface, upon which the capillary vessels of the umbilical arteries are minutely ramified. These processes gradually prolong themselves outwards, and carry along with them the umbilical vessels, which gradually become larger and more numerous *. At the same time, the projections situated on the inner membrane of the uterus, corresponding in position and form with those on the chorion of the ovum, become enlarged; into these processes of the uterus the projecting parts of the chorion are gradually inserted. These placental processes of the mother are also very vascular, so that the umbilical arteries of the fœtus carrying venous blood, are brought into contact with those carrying the arterial blood of the uterus, by the influence of which the necessary change or arterialization seems to be effected †.

After a little more than a sixth of the time of uterine gestation has elapsed, at which period the fœtus of the mammiferous animal corresponds in its structure to the chick in ovo on the third and fourth days, rudiments of a branchial apparatus, analogous to those already alluded to in the higher reptiles and in birds, are to be found. We are indebted chiefly to Rathke, Baer, and Burdach for the discovery and elucidation of these interesting facts. The observations of these authors have principally been made on the embryoes of the cow, pig, sheep, dog, rabbit, and of the human species, and the appearances they have observed in all of these animals have been so similar, as to warrant the conclusion, that they are common to all or most of the mammiferous families. The general features in the structure of the neck and pharynx, which assimilate the embryo of the mammiferous animal to that of the aquatic animal in the early stages of their development, are the same as those already mentioned in birds. They consist in the shortness and thickness of the neck, the width of the pharyngeal portion of the intestine, the penetration of its sides by clefts, and the subdivision of the aorta into vessels corresponding in number and distribution with the primitive branchial arteries.

Four openings on each side of the œsophagus have been observed in the embryo of the dog, between three and four

* See a paper by Sir E. Home, Phil. Trans. vol. cxii.; and Burdach's Physiol., B. ii. S. 534.

† For an account of the varieties of the form and nature of the placenta in different classes of animals; see another paper by Sir E. Home in the Phil. Trans.—Carus' Comparative Anatomy, 2d vol.—Jeffray de Placenta, &c.

weeks old *; in that of the sheep of three weeks; of the pig at three weeks (Fig. 9. part I. and Fig. 37.), and of the rabbit on the twelfth day; and in the human embryo of six weeks (Fig. 36.): in the embryo of the dog, some little time before that mentioned above, only three apertures are found. The buccal opening situated anteriorly to the branchial clefts, the inferior maxilla, the hyoid bone, and the opercular fold of integuments, which closes the anterior clefts, are developed in the same manner as in the bird. While three pairs of clefts exist in the sides of the pharynx, there are in the dog (Fig. 35. *m*), as in the chick, only four pairs of vascular arches; but before the first of these becomes obliterated, a posterior or fifth pair is produced, while, at the same time, the fourth branchial cleft is formed; so that in the mammiferous animal five pairs of vascular arches, and four pairs of clefts, exist for some time simultaneously in the sides of the neck †.

A few days after the appearance of the fifth arch, the neck begins to elongate, the apertures are closed gradually on the outside, and the lower jaw becomes more developed; while the vascular arches undergo those changes by which the permanent arterial branches, arising from the heart, are formed.

The first and third pair of vascular arches form the carotid and subclavian arteries in Mammalia (Fig. 39. *t*, *u*), as in birds, and the second pair seems to be wholly obliterated, or at least gives only a small branch; in mammalia, however, the arch of the aorta, or permanent communicating vessel between the ascending and descending aorta, is formed from the fourth branchial arch on the left side (*r*) of the œsophagus; so that the order in which the vessels of the head and superior extremities arise is

* See Fig. 35. the head of the fœtal dog represented by Baer, and given in the first part of the Essay, which I have again inserted, in order that this interesting point of structure may be brought more immediately before the eyes of the reader.

† The vascular arches of mammalia are described by Rathke and Baer in the greater number of embryoes in which they have been seen, as simple tubes; but, in one instance, the latter author observed, on the internal and concave border of each vascular arch another small vessel, of which, he says, "je n'ai pas pu saisir les rapports." Could this have been the lateral vessel which, in the frog, gives off the smaller branches to the leaflets of the gill?

reversed; the right innominata taking its origin before the vessels of the left side *.

The pulmonary vessels appear to be given off by the fourth arch on the right and the fifth on the left side (*p' p*), the fifth on the right being wholly obliterated. While, however, the carotid and branchial arteries become developed from the anterior arches, the pulmonary arches do not continue to carry blood to the root of the aorta, as takes place in those of the bird. The parts by which these arches communicate with the root of the descending aorta (forming in birds the ductus botalli) become gradually obliterated, so that of all the five pairs of vascular arches in the embryo of the mammiferous animal, only one, the fourth of the left side, remains prominent.

While these changes take place in the pulmonary arches, the bulb of the aorta, from the single cavity of which the pulmonary and systemic vessels arise for some time in common, is divided, so as to form the roots of the aorta proper and pulmonary arteries. According to Meckel †, the septum which has separated the left ventricle entirely from the right, appears to be continued onwards into the bulb of the aorta, and thus separates this cavity longitudinally into two compartments. The division of the bulb is, however, imperfect for a time; it advances gradually from the part next the ventricle to that from which the vascular arches rise; so that, while the posterior part is divided, the anterior yet remains single, a communication being left at this part between the aortic and pulmonary roots, which admits of the passage of the blood from the right ventricle into the aorta, when the pulmonary arches are obliterated (Fig. 39. A). When the division of the aortic bulb has just taken place, the arch and descending part of the aorta appear to be a continuation of the pulmonary rather than of the aortic root, the latter appearing to lead only into the vessels of the head and anterior extremities. The ductus arteriosus remains for some time, as at first, short and wide, and has the appearance of being an opening of communication between, or a deficiency in, the parietes of the juxtaposed tubes; it afterwards becomes lengthened out and narrowed, and appears during a short

* In birds, the left innominata comes off from the aorta first.

† Meckel's Archiv. B. ii. h. 3; and Journal Complémentaire, tom i.

period to pass from the aorta to the pulmonary root and aorta continuous with it; but about the tenth week in the human embryo, this part is dilated, and forms a more direct communication between the ascending and the descending aorta, and the ductus botalli is now formed by another part, viz. the end of the pulmonary root leading into the arch of the aorta (Fig. 43).

The lungs of mammiferous animals are developed much in the same manner as those of birds, at least in the earlier stages of their growth. They do not appear to be visible before the period when the branchial apertures begin to close. According to Rathke both lungs are simultaneously produced; they form at first one mass, which is soon divided into the rudiments of the right and left lung by a longitudinal groove (Figs. 40, 41, 42, L). The apertures or tubes of the bronchi and trachea seem to begin in the same way as in birds; but the cellular part of the lung does not become so highly developed as in them, and is intimately united with the bronchial tubes throughout the whole lung. (See the figures taken from Rathke). As the lungs become larger, they receive vessels from the pulmonary arches, which gradually enlarging as the fœtus becomes developed, divert the stream of blood from the arterial duct of the aorta. This latter opening now diminishes in size, and, at birth, when the efflux of blood to the lungs is suddenly increased, it is closed up.

Having now given a short sketch of the general phenomena which manifest themselves during the development of the rudimentary organs in the embryo of vertebrated animals, and having traced in detail the progress of the heart, bloodvessels, and respiratory organs, during their formation and early growth, it may be proper, in conclusion, to recapitulate the more remarkable facts, or general principles, relating to these subjects, which the observations that have just passed under review appear to establish.

I. From the short account which was given, in the commencement of the Essay, of the formation or origin of parts in the earliest stages of fœtal development, it cannot but be apparent that, whatever opinion is formed respecting the nature of the germ, or speck round which the commencing parts of the embryo appear to arrange themselves, there is nothing in the appearance or structure of the germinating spot, so far at least as has been ascertained by the accurate investigations of the most eminent physiologists, which assimilates any of its parts to those of the fœtus or perfect animal, the formation of which it precedes. We seem entitled, therefore, in the present state of our knowledge, to regard these germs as wholly invisible—perhaps entirely imaginary, since their existence is only inferred from phenomena which occur during the development of the embryo.

II. We have had an opportunity also of observing how very different the parts of the embryo are on their first appearance in the ovum, from those parts which they represent, and into which they are transformed at a later stage of fœtal life, or after birth; and we have seen how gradual the change is by which this transition is effected.

III. From the important place which the cerebral and circulating organs occupy in the perfectly formed animal, many have believed that the formation of the brain and heart precedes that of all other parts; but it has been shown that, though these are among the organs which appear to be most highly developed or perfected soonest, yet before the commencement of their formation, and certainly before any parts, which may with justice be compared, in function or structure, to these organs, are produced, the substance is deposited from which the head, trunk, and extremities are formed.

The heart has also been supposed to take its origin in consequence of some influence derived from the brain and spinal cord; and many have imagined that the development of the greater number of organs in the body, follows necessarily the presence of the heart, or of certain bloodvessels; but the phenomena of the development of these parts appear to prove such ideas to be erroneous, and to show that we are as yet ignorant of any particular influence which the pre-existence of one part in the early stages of its advancement exerts on the formation of another. Many observations, indeed, show that the brain and heart are nearly simultaneously produced, and that in all those parts which may be examined with ease, a certain quantity of their parenchyma is formed, before they receive the bloodvessels which, at a later period, serve for their nutrition.

IV. The general resemblance which the changes of development in the ova or fœtuses of vertebrated animals bear to one another, is very striking; it illustrates the analogy of structure in the different animals of this class when arrived at their state of maturity, and seems to indicate very clearly, that the general plan upon which their systems and organs are constructed and arranged is the same. This correspondence, indeed, in the relations of organs to one another, and similarity in their construction, to which the name of Type of Organization has been given, appears to be comparatively much more clearly understood, from the knowledge, confined as it yet is, of the development and transformation of the fœtus, than from the immense number of facts which have been established by the examination of the structure of animals in their perfect state.

In examining the embryoes of the vertebrated animals, at a corresponding period in the early stages of their development, it is truly surprising to remark how very much they resemble one another. In some of the higher orders especially, it would be difficult for those unaccustomed to such investigations, to distinguish between the embryoes of the lizard, bird, or mammiferous animal, when they are removed from their ova and divested of the accessory membranes; and impossible for the experienced eye even, to perceive the differences between the embryoes of the different families of the same order, as of birds or mammalia.

The following may be regarded as some of the more important particulars in which the phenomena of development correspond in the different orders of vertebrated animals:—1. The ovum being essentially composed of a yolk, or collection of granular substance, enclosed in a membrane, along with some accessory parts, all enveloped by a general covering, to which the name of chorion may be most properly applied. 2. The existence of some part of the yolk, generally of a firmer consistence than the rest, situated towards the upper surface, and of a membranous form, called the germinal membrane, in which the changes connected with the formation of the fœtus more immediately take place. 3. The commencement of the formation of the embryo being indicated by the appearance of a streak and small groove, in the centre of the germinal membrane, and this groove afterwards forming the rudiment of, or being converted into, the spinal canal. 4. The separation of the substance of the germinal membrane into three layers, in which different systems of the animal appear to originate. 5. The expansion of these layers of the germinal membrane over the surface of the yolk, so as to form a new covering for this part, situated within its proper membrane; and the development of blood, and of a vascular network on the surface of this covering or yolk-sac. 6. The development of the head, trunk, and extremities, from the outermost or serous layer, as it has been called; the formation of the anterior and posterior extremities taking place sooner or later, according to the circumstances in which development is effected, and according to the mode of life of the perfect animal. 7. The formation of the cavities destined to contain the brain and spinal cord from folds and thickenings of the same layer. 8. The development of the organs of the senses from these cavities, and their contained parts; the early appearance of the eye and ear especially. 9. The formation of the principal circulating organs, such as the heart and larger bloodvessels, from the middle, or, as it has been named, vascular layer. And, 10. The development of the intestinal, respiratory, and some of the principal secretory organs, by means of folds and other changes of the two interior, or vascular and mucous layers of the germinal membrane. These phenomena, occurring during the development of the fœtuses of vertebrated animals, are so nearly alike, that they may be considered as a strong corroboration of the opinion, that the general plan of construction and arrangement of the organs of all these animals is the same.

V. The same extent of knowledge of the development of the fœtus of Avertebrated animals has not as yet been obtained; but it appears probable that, notwithstanding the great dissimilarity between the adult members of this class of animals, the observation of the manner in which their organs originate and become developed, may tend also to elucidate their connexions, and point out analogies where they were not before suspected to exist.

Such a knowledge would, I doubt not, instruct us also on the important question which has lately engaged the attention of two of the most distinguished comparative anatomists in France, viz. whether there exists any analogy between the general plan of arrangement in the organs of vertebrated, and those of avertebrated animals; or inform us whether, among the latter, there is any order or family, resembling more than the others the vertebrata, which forms the connecting link between the simpler and more complicated class of animals. The few observations which have as yet been made on this subject, by those who possessed a general acquaintance with the phenomena of development, have already laid the foundation of this knowledge, and have pointed out some curious and interesting points of resemblance between vertebral and avertebral animals, in regard to which the greatest dissimilarity was previously believed to exist *.

VI. During the development of any of the vertebrated animals, as the germinating speck passes from the form of a granular mass, in which it first makes its appearance, to the state of embryo in which we perceive the rude sketches of its principal organs, and gradually assumes the more perfect form of fœtus differing little from the adult, the animal makes a gradual transition from a simpler to a more complicated organization. Hence has arisen the opinion, not uncommon among physiologists, that the fœtus, at every successive period of its development, assumes the form of some animal inferior to it in the perfection of its structure. From the analogy which we have already stated to exist between the mode of development of different orders of vertebrated animals, and from the gradual manner in which the complication of their structure is increased, as well as from the resemblance well known to exist in the general plan of their construction, it will immediately be apparent that the fœtus of the higher orders of these animals must resemble, at different successive periods, to a certain extent, the adult members of the lower orders; but as the periods at which all the organs correspond are not the same, the resemblance must be considered as imperfect, and is more apparent in respect to particular organs than to general structure. Many differences exist between the organization of vertebrated and avertebrated animals, of so important a nature as to render any comparison such as that just noticed vague and unsatisfactory at any period of the fœtal development.

VII. In regard to the formation of the heart, it seems to be

* See Burdach's Physiol. B. ii. Rathke's and Forchhammer's observations on the development of the craw-fish, lobster, &c.

established by the observations previously related, that, 1st, this organ consists at first, in all vertebrated animals, of a simple membranous tube, forming a continuation, and connected with the venous and arterial vessels. 2d, This tube of the heart is invariably situated on the lower and anterior side of the œsophagus. 3d, The blood at first enters this tube towards its posterior extremity, and on the left side of the body, and issues at the anterior extremity, and towards the right side. 4th, The changes which the tube undergoes in its gradual conversion into the heart of the adult, are, to a certain extent, the same, or at least analogous, in all the orders of vertebrata. 5th, The auricle and bulb of the aorta are separated from the ventricle by a constriction in the paries of the tube. 6th, A curvature takes place in the tube, so as to bring together its two extremities, or to make the auricle and bulb of the aorta approach one another; this curvature being such, that the auricle is always situated behind, or rather above the ventricles. 7th, In fishes and batrachia, the form of the heart is perfected, the ventricle becomes very thick and muscular, the auricle is dilated, and valves are formed near the apertures, while this organ remains simple and undivided, or while the blood which enters it is propelled through a single vessel. 8th, In lizards, serpents, and turtles, while the same or analogous changes take place in the general structure of the heart, in the strength and thickness of its parietes, or in the relative position of its parts, the cavities of this organ are more or less completely divided, so as to separate the blood which passes through it into more than one stream; the auricle being divided by the formation of a septum advancing from above downwards, the ventricle, by a partition which rises from the apex towards the base. 9th, The heart of birds and mammalia is seen to undergo the same subdivision, and the right and left cavities communicate for some period of fœtal life with one another; but, in these animals, the partitions by which the auricles and ventricles are separated become complete, and no longer leave any opening from the cavities on one side of the heart into those of the other. 10th, In mammalia, the growth of the septum, in the interior of the ventricle, is accompanied by the formation of a notch or constriction on the outside, by which the apex of the heart is rendered double for a time. 11th, At the same time, in the higher reptiles, birds, and mammalia, the bulb of the aorta is also divided, so as to enable each of the ventricles to communicate with those vessels only into which they propel the blood during the whole of life.

VIII. We have seen, that, in the early stages of development, there is a uniform disposition of the greater arterial trunks in all the orders of vertebrated animals, though the distribution of these vessels is by no means the same as that which exists permanently. The arteries arising from the bulb of the aorta, and connected with the respiratory organs of the neck, have been chiefly referred to, as affording one of the most remarkable examples of this uniformity of disposition in the vessels of the fœtus, and of the variety of transformation which they undergo during their conversion into the permanent structure.

IX. We have seen that, in all vertebrated animals, the anterior intestinal part of the tube is encompassed by four or five * pairs of arterial vessels, formed by the subdivision of the ascending aorta, and that these vessels, after passing round the œsophagus, unite again with one another above this tube, and below the vertebral column, to form the dorsal aorta.

X. It has been seen, that, in the lower aquatic animals, gills become developed along the course of parts of these vessels, while in the higher or air-breathing animals, after being so disposed as to indicate slightly the appearance of gills, these vessels are gradually converted into the systemic and pulmonic arteries by the processes of enlargement, partial obliteration, separation, &c. Though the general phenomena occurring during this transformation of the arteries in the neck, are analogous in all vertebrated animals, there are certain remarkable differences respecting the obliteration of some, and the permanence of others of these vessels, in various species of animals. 1. In cartilaginous fishes, all the branchial divisions of the aorta remain permanent to form gills, undergoing very minute subdivision in these organs, so as to be converted into branchial arteries and veins. 2. In osseous fishes, five pairs of branchial arches are also observed in the fœtus, but only four of

* It appears probable that there are five in all vertebrated animals, excepting the lamprey, myxine, and some others. Baer has endeavoured to demonstrate this in his essay on this subject in the 7th vol. of the Répert. Génér.

these remain to form the gills, the anterior being partly obliterated, gives rise to the roots of the carotid or head artery. 3. In batrachia, we have seen, there is a gradual transition from the structure of fishes to that of the higher reptiles. The gills in the batrachia are, during some period of their existence, developed along the course, or from particular parts of the branchial arches, in which, as in fishes, minutely subdivided branchial arteries and veins are formed; but these last gradually disappear, and more or fewer of the primitive branchial vessels remain. *a.* In the batrachia with permanent tails, the aorta is formed, as in the fœtus, by the union of the whole four branchial arches on each side, the pulmonary artery arising from the posterior arch; *b.* while in the batrachia without tails, as in the frog, only one branchial vessel remains on each side, so as to form the right and left roots of the aorta; and the pulmonary artery, which in the fœtus was given off from the posterior branchial arch, appears to spring from the aortic root itself, in consequence of the obliteration of the posterior part of the arch communicating with the descending aorta. 4. We have seen that two branchial arches also remain entire in the saurian and chelonian reptiles; but in these, as well as in all the other animals in which the ventricular part of the heart is more or less divided in the progress of development, the pulmonary arteries —formed, as in batrachia, by the posterior branchial arch—are separated from the aorta and its branches; each of these sets of vessels communicating directly with its proper ventricular cavity. 5. In birds, the second pair of arches, and the fifth arch of the right side, are wholly obliterated without giving rise to any branches. The first and third form the arteriæ innominatæ or carotid and subclavian arteries on both sides, the communicating branches between these arches and the roots of the aorta, being obliterated at an early period. The fourth arch on the right side alone remains entirely pervious during the whole of life, and forms the proper trunk of the aorta from which the innominatæ spring. The fourth arch on the left, and the fifth on the right side, united in a common root, give rise to the pulmonary arteries. These arches remain pervious till birth, forming the ductus botalli or arterial ducts leading from the right ventricle into the aorta. 6. In mammalia, nearly the same changes take place in the transformation of the anterior arches; but the aorta is formed in them by the fourth arch on the *left* side, this vessel descending on the left side of the œsophagus. The fourth arch on the right, and fifth on the left side, appear to give rise to the pulmonary arteries. In the mammalia, the ductus botalli is formed, not as in birds or lizards, by the permanence of the posterior part of the pulmonary arches, but by a communication which remains in the bulb of the aorta between the roots of the pulmonic and systemic trunks *. Thus it is explained how the aorta of birds corresponds with the right root of this vessel in lizards, and that of mammalia with the left; the arteria innominata of the left side being first given off in birds, while, in mammalia, that on the right springs first from the aorta.

XI. From these observations, it appears that it is erroneous to compare the single heart of fishes or batrachia with the right side or pulmonary cavities of the heart of higher animals. They are similar, it is true, in this respect, that they both propel the blood into a respiratory organ; but the relation of the gills differs widely from that of the lungs to the heart; and it would be more correct to compare the single heart of fishes with the whole heart of the higher animals though divided, or with this organ in the early stages of their fœtal development.

XII. We have had an opportunity of observing, that as we ascend in the series of vertebrated animals, the processes by which respiration is carried on in the fœtus, become gradually more and more complicated. 1. The ova of fishes are deposited and developed in the same medium in which the adult animal continues to live: *a.* in osseous fishes, the blood is exposed to the influence of the respiratory medium on the sac of the yolk; *b.* and in cartilaginous fishes both on the yolk sac, and in external gills. 2. The ova of batrachian reptiles are deposited, and become developed in water; while the animal, in its adult state, breathes air. The blood in the larva or fœtus of these animals is arterialized by means of a yolk little developed, and by external and internal gills: and in the animal arrived at maturity, by means of lungs, and a large urinary bladder or allantois.

* There is an approach to this form in the structure of the vessels rising from the heart in some of the saurian reptiles.

3. In the saurian, ophidian, and chelonian reptiles, the ovum being generally deposited in the medium which the animal permanently breathes *, an amnios or covering for the fœtus is formed, by means of which it is kept immersed in a fluid, till the time when it is enabled to respire air; respiration being carried on, during the fœtal life of these reptiles, by the sac of the yolk and allantoid vesicle highly developed. Some of these reptiles, however, seem to be allied in some respects with the batrachia, as in them part or whole of the allantois remains permanent in the adult state. 4. In birds, the application of a considerable external heat is necessary to induce the proper respiratory alteration of the blood, which is exposed, as in the previous class, on the yolk and allantois,—membranes very highly developed in birds. In these animals, a very small pedicle only of the allantois, the urachus, remains in the fœtus after birth. 5. In mammalia, again, the ovum being retained in the body of the mother, the respiratory changes are effected by the intervention of the maternal blood; and another organ, formed by an extension of the umbilical vessels, is superadded in mammalia to the yolk and allantoid, which exist as in birds. This is the placenta, by means of which vessels, containing the venous blood of the fœtus, are brought closely into contact with the vessels lining the uterus, and containing blood more highly aërated, by which contact their respiration is effected.

XIII. It has also been shewn in the preceding relation, that the gills are invariably formed on processes of the hyoid bone, which are either permanent, as in fishes, or exist only during the larval state, as in batrachia. The operculum is developed from the posterior part of the lower jaw, and this part, as well as the branchiostegous membrane, appears to be intimately connected with the lingual bone or the lateral branches of the hyoid.

XIV. The observations related above, seem to shew that the lungs, though they receive their vessels from branchial arches, which, during some period of fœtal life, are distributed on gills or analogous parts, cannot with accuracy be compared to these latter organs, as has been attempted. The lungs, it has been shewn,

* Making exception in these, as well as other animals, of such as become developed in the body of the parent.

are developed on the lower side of the œsophagus, but they do not appear to be formed by a process or diverticulum from the intestinal tube, as observation shews that they are not hollow when first formed, and that a cavity exists for some time in their interior, without its communicating with the hollow of the intestine.

In conclusion, I may state, that, in the preceding pages, I have endeavoured to give as short, and at the same time as accurate, an account of the subjects treated of as their difficulty, and the obscurity which still hangs over many facts connected with them, have enabled me to do.

In many parts I have stated only those of the facts which appear to be most probable, judging of them either from the relations of others to which I have had access, or by observations which I have myself made in confirmation of them. In selecting the drawings which have been given, I have always chosen to copy the delineation of others, when I found that they represented sufficiently accurately the appearances related.

Since writing the above, I have had an opportunity of seeing, in the Number of the Annales des Sciences Naturelles for September last, the fourth memoir by M. Serres on Transcendental Anatomy, in which this author treats of the Law of Symmetry and Conjunction in the Vascular system of vertebrated animals.

In that memoir, M. Serres relates some minute observations which he has made on the development of several parts of the vascular system, from which he has been led to describe the origin of some of the principal arteries of the body, in a manner different from that generally received by those who have written on this subject, and to form the conclusion, that all single arteries, situated in the median plane of the body, are at first double; that they are formed by the union of two vessels, and that the "Duality of arteries tends to Unity from without inwards, by the laws of formation from the circumference to the centre, or of symmetry and conjunction."

The principal arteries which M. Serres describes as formed and united in the manner alluded to are the Aorta, the Arteria basilaris and Arteria callosa cerebri, and the Umbilical arteries in the funis of the allantois; and he adduces in support of his conclusion observations on the structure of these arteries in the fœtus of birds and mammalia at an early stage of its advancement, in cases of malformation, and in the different orders of vertebrated animals in their adult state.

In speaking of the formation of the aorta, M. Serres refers to the observation made by the greater number of those who have attended minutely to the development of the chick (more especially by Pander, Beiträge zur Entwickelungsgeschichte, &c. § 13. pl. viii.), that, towards the 60th hour of incubation, the aorta of the chick consists of two vessels quite separate from one another, in the abdominal part of the vessel where it gives off the arteries of the vascular area.

At this period, the abdominal part of the embryo consists simply of the rudimentary vertebral column inclosing the spinal cord, of the lateral thickened parts of the serous layer of the germinal membrane which form the plates of the abdomen, and of the commencing intestinal folds on the lower surface,—which parts are situated nearly in the same plane with the horizontal part of the germinal membrane. About the middle of this part of the embryo, the two arteries of the vascular area are seen proceeding from it to the transparent and vascular areas; while the aortic branches, with which they communicate, form two parallel vessels, situated one on each side of the rudiments of the vertebræ, and extending from the part of the back opposite to the ventricle of the heart, where they are joined into one trunk, to the end of the tail.

Both Pander and M. Serres have given the name of Umbilical to the arteries of the vascular area, a circumstance which has in some measure tended to obscure their description of them. Pander, indeed, forgetting that the proper umbilical arteries, distributed on the allantois, are produced from the pelvic portions of the aorta, at a period considerably later than the vessels of the area, supposes that the only difference between the structure of the aorta in the fœtus, and that in the adult animal, consists in the greater height at which the division of this vessel into the iliac arteries takes place; but this, it is obvious, affords no explanation of the circumstance, that the arteries of the vascular area of the yolk, (forming as their more recent and appropriate name of Omphalo-mesenteric implies), continuations of the intestinal arteries, are each of them given off by a separate branch of the aorta.

M. Serres has also observed, that, between the 40th and 50th hours, or immediately after the circulation of the blood has commenced, the trunk of the aorta is double in its whole extent, from the place at which its branches spring from the bulb of the heart to the end of the tail; and he affirms that it is by the gradual union of these two vessels on the median line that the single aorta of the adult is formed.

Baer, the accuracy of whose researches on development we have so often had occasion to admire, had also directed his attention to the state of the aorta in the early stages of incubation, but apparently without the same success. In his history of the development of the chick (Répert. Génér. d'Anat. et de Physiol. tom. 8. p. 72.), he informs us, that the two vessels into which the ventricle of the heart propels its contents, towards the 40th hour, having passed round the anterior part of the intestinal tube, and proceeded some way along the inferior surface of the vertebral column, *probably* reunite after having been separated for a certain space. He says, that this union cannot, however, be easily shown at this period, because these vessels, on arriving below the vertebral column, appear to lose their parietes, and their contents are too transparent to enable us to trace their course. He adds, that their union can, however, be easily demonstrated before the end of the second day.

These remarks of Baer, and the circumstance that M. Serres makes no allusion in his description of the primitive double state of the aorta, to the existence of the ten branchial subdivisions of this vessel discovered by Huschke, Rathke and Baer, and described at p. 64. of this essay, and that he has given us no information on the means he employed in making this very difficult investigation, have made me think the repetition of the observations of M. Serres necessary, in order not only to inquire into their accuracy, but to endeavour to point out the relations of the two aortic branches described by M. Serres, to the dorsal roots of the aorta formed by the union of the branchial arches on each side of the intestine.

From the very cold state of the weather at the time I made these observations, I found it very difficult to keep the chick alive on the field of the microscope, and to observe the circulation of the blood going on, at the early stage of advancement necessary in this investigation, and I was obliged to have recourse to the plan of making transverse sections of the fœtus in the whole length of its body, in order to ascertain the structure of its vessels,—a mode of observation by no means easy, but one which affords most certain and satisfactory results. In this manner, I have been enabled to confirm the general results stated by M. Serres in regard to the double state of the aorta, in the early stages of the development of the fœtal bird.

In the chick, at the 36th and at the 40th hours of incubation *, or a little before and immediately after the circulation of the blood commences, I have seen two vessels rising from the bulb of the heart, winding round the anterior portion of the intestine, and continuing to descend along the body of the fœtus, parallel to but separate from one another in their whole length. These vessels are situated below the spinal marrow, and on each side of the chorda dorsalis †, or part afterwards occupied by the bodies of the vertebræ. The omphalo-mesenteric arteries are given off from these vessels considerably higher at this than at a later period, and at first sight appear to be the only branches continued from the aortic vessels; but on minute examination, two other smaller vessels may be seen, situated between the omphalo-mesenterics, and descending some little way below the place where these latter arteries pass off into the vascular area: towards the tail of the embryo, these two continuations of the aortic vessels seem to lose themselves in a large vacant space left between the vascular layer of the germinal membrane and the chorda dorsalis.

In the chick at the 48th or 50th hours, or at the period when

* In mentioning the hours of incubation, I state the period, not according to the time occupied in the incubation of the individual fœtuses employed, but according to the state of their advancement, and the general periods adopted by Baer, Prevost and Dumas, &c.

† The Chorda dorsalis, so called by Baer, corresponds in its position to the primitive streak of the cicatricula: it is a small dense cord, situated immediately below the spinal marrow.

the circulation of the blood is now completely established on the vascular area, but before the second set of veins have appeared, I have found the two aortic vessels united for a considerable space in the dorsal region. This union seems to commence in the back, nearly opposite to the auricle, but I have not been able to ascertain the precise period at which this process begins: it gradually extends backwards towards the tail, so that, at the 60th or 65th hour, the whole of the dorsal and part of the abdominal aorta is one tube, as far as the place where the omphalo-mesenteric arteries are given off. The omphalo-mesenteric arteries, being shortly after this partially united, appear to arise from one stem.

On the fourth day, the whole of the two abdominal portions of the aorta becomes united, as far as the region where the permanent division of this vessel takes place: here the vessels remain separate, and furnish the umbilical arteries or vessels of the allantoid membrane, which now begins to be developed,—these being the first considerable branches of the iliac arteries which are formed.

While this union of the dorsal and abdominal portions of the double aorta takes place, the two vessels arising from the bulb of the heart, of which the aortæ formed at first the continuation, do not, like these, become united into one trunk, as the observations of M. Serres would lead us to believe. I have already described these two vessels * as the first pair of branchial arches, the posterior parts of which form the separate roots of the aorta to be found in the chick on the third and fourth days of incubation; these roots being also joined at this period by the four other branchial arches which appear successively on each side of the pharynx. These roots of the aorta and branchial arches, we have already remarked, do not become united to one another, but undergo other very remarkable changes, by their partial enlargement or obliteration. Parts of the first branchial arches give rise to the carotid arteries in all vertebrated animals: while the proper trunk of the aorta, or at least its ascending portion and arch, is produced from other branchial vessels, and the roots into which they are joined; one or more of these serving to form the aorta, according to the

* See page 257, &c. and figs. 20, 21, and 30. in the last Plate.

class of animals in which the transformation occurs. In Mammalia, the aorta is formed by the permanence of the fourth branchial arch and the aortic root of the left side; in Birds by that on the right; in the greater number of Reptiles by one on each side; in the tailed Batrachia by three or four arches on each side and by both roots; in Osseous Fishes by four; and in the Sharks, Skates, &c. by all the five pairs of branchial vessels and the two roots which are to be found in the early stages of development in the fœtus *.

The discovery of the double state of the dorsal and abdominal aorta in the very young fœtus, made by M. Serres, must, however, be regarded as very interesting, not only as it points out a very singular change, little attended to before it was investigated by this author, taking place in the median arteries, but also as it seems to afford an explanation of some varieties in the place of junction of the roots of the aorta, and in the origin of the cœliac, mesenteric and other arteries, which occur in several tribes of reptiles.

The observations of this author in regard to the union of the double arteriæ Basilares and Callosæ, will be read with equal interest, as well as several curious facts mentioned by him respecting the union of the principal venous trunks, and the varieties of distribution of the vessels in the umbilical cord in some mammiferous animals. A. T.

Dec. 30. 1830.

* See Figs. 1. 9. 11. 14. 15. 19. 20. 30. 35. 39. in the two last plates.

ERRATA.

Part 1.	page 304,	line 35,	*for* takes *read* take
....	... 307,	... 9,	... fig. 17 ...... fig. 16.
....	... 320,	... 9,	... 20. *d c* ...... 20. *c.*
....	... 326,	... 17,	*after* 8 and 9 *add* (from Baer)
...... 2.	... 96,	... 15,	*dele* (figs. 2. & 3 •)
...... 3.	... 267,	... 6,	*for* branchial *read* brachial
....	... ...	... 13,	... prominent. ... permanent.
....	... ...		*At the foot add the following note:*

In the page above, the formation of the Ductus arteriosus in mammalia has been described in the manner in which Meckel supposed it to take place; but since writing this description, I have made some observations on the fœtus of the sow and sheep, which induce me to believe, along with Burdach, that the opinion of Meckel is incorrect, and that the single ductus arteriosus is formed in these and other mammiferous animals in the same manner as one of the two ducts which exist in birds and some reptiles, viz. by the permanence of one of the branchial arches. The fifth branchial arch on the left side, (marked W in fig. 39 of last Plate), is the one which appears to give rise to this communicating vessel in mammalia.

Analysis of a powerful Chalybeate Water from Vicar's Bridge, near Dollar in Clackmannanshire. By Arthur Connell, Esq. F. R. S. E. Communicated by the Author.

This mineral water was first, I believe, observed in the course of last summer, and has excited considerable interest in the neighbourhood of the place where it is found. It has been much used medicinally by the common people of the vicinity; in all probability in many complaints for which it was very ill adapted. It has, however, been found beneficial, when employed with a due regard to its great strength, in some of those diseases for which iron is of advantage; and it has now made its way to other places.

The water is described by my friend Mr Tait, who sent to me a portion of it for analysis, as being found in those mines or excavations from which clay ironstone is obtained at Vicar's Bridge. The excavations are worked out in beds of a kind of shale which contains the iron-ore; and the water forms separate pools on the floor or pavement of the several compartments of the mines. The beds of shale probably form a part of the coal-strata of the neighbourhood, although I have not had any opportunity of examining them. The general appearance of the water of these several pools is described as being much the same, although the solutions are supposed to differ somewhat in strength. That sent to me was conceived to be the strongest impregnation.

The colour of the water was a dark red. Its taste strongly astringent, with some acidity. It reddened litmus paper. Its specific gravity at 62° F. was 1.04893. This high state of concentration constitutes its principal peculiarity. The above specific gravity is considerably greater than that of sea water; and exceeds that of any other natural saline impregnation of which I have read, either in Great Britain or in foreign countries, with the exception of the water of the Dead Sea.

The action of reagents was as follows: With respect to those reactions, showing the presence of iron, I shall be a little particular, with the view of determining the state of oxidation of the iron.

The ferro-prussiate of potash gave immediately a very dark blue precipitate; and when much diluted, the sulpho-cyanate of potash produced a red precipitate. These reactions of course were due to the presence of peroxide of iron.

Recently after the water had come into my possession, it gave with ammonia a dark olive precipitate, becoming reddish by exposure to the air. This reaction showed that some protoxide of iron accompanied the peroxide. After it had been kept some weeks in a corked bottle, it gave a precipitate with ammonia which was reddish-yellow on first falling. With the red cyanuret of iron and potassium, a blue or greenish-blue precipitate fell, either immediately or after a short time. The action with this reagent continued much the same, even after the water had ceased to give a dark-coloured precipitate with ammonia. These appearances also showed the presence of protoxide of iron.

The infusion of nutgalls produced a very fine deep blue, indicating the presence of peroxide of iron, or rather a mixture of the peroxide and protoxide*.

When the precipitate by ammonia was boiled with caustic potash ley, the alkaline solution, examined by ordinary means, showed the presence of alumina.

After precipitating by ammonia, filtering and concentrating considerably by heat, oxalate of ammonia indicated a little lime.

When the oxalate of lime had been separated, and the liquid again concentrated, carbonate of ammonia and phosphate of soda showed the presence of magnesia.

With muriate of baryta, the water, even when considerably diluted, gave a precipitate; showing abundance of sulphuric acid.

When a little of the water was precipitated by ammonia, and the clear liquid considerably concentrated, sulphate of silver caused a slight muddiness, and after a time a very slight precipitate collected, which was dissolved by ammonia; indicating the presence of a minute quantity of muriatic acid.

The constituents of which we have thus found evidence are,

* So great is the concentration of the water, that the resulting mixture is of sufficient consistency to constitute a writing ink; and it has been used by several persons for this purpose, at least when a little gum-arabic has been added to the mixture.

peroxide and protoxide of iron, alumina, magnesia, lime, sulphuric and muriatic acids. In the course of the following analysis, minute quantities of one or more alkalies will also appear.

The proportions of these constituents were determined in the following manner:

(*a*) 3 cubic inches of the water were evaporated to dryness in a platinum crucible. The reddish-grey residue weighed 45.15 grains.

(*b*) 3 cubic inches were precipitated by ammonia. The precipitate was dissolved in muriatic acid, and the solution digested with excess of potash. The oxide of iron, after being separated by filtration and ignited, weighed 16.64 grains*.

(*c*) The alkaline solution, by supersaturation with muriatic acid, and precipitation by carbonate of ammonia, afforded 1.95 grains of alumina.

(*d*) The liquid which had been precipitated by ammonia in (*b*) was concentrated by heat, and oxalate of ammonia then added; the precipitate was collected, calcined, and heated with carbonate of ammonia; .35 grain of carbonate of lime was thus obtained, equivalent to .195 of lime.

(*e*) The liquid separated from oxalate of lime was evaporated to dryness, and the residue calcined. A white saline mass was obtained, which weighed 3.05 grains. It dissolved in water, except a few flocks, which, after ignition, weighed .02.

(*f*) The filtered solution was precipitated by acetate of baryta, and after the sulphate of baryta had been separated by filtration, the solution was evaporated to dryness, and the residue ignited. The ignited mass was treated with water. To the liquid, after being separated from the undissolved matter, muriatic acid was added. It was then evaporated to dryness, and the matter obtained redissolved in water.

(*g*) This solution, by spontaneous evaporation, gave a residue exhibiting a very small quantity of minute cubes or square tables, evidently either common salt or chloride of potassium. After the removal by alcohol of a minute quantity of deliquescent matter which accompanied it, and subsequent ignition, it

* It retained a very slight trace of magnesia, which had been thrown down by the ammonia.

weighed .03 grains. On examining its solution in water by muriate of platinum, it appeared to contain both soda and potash.

(*h*) The matter left undissolved by the water in *f* was treated with dilute sulphuric acid, the solution filtered and evaporated to dryness; and the residue ignited. Redissolved in water, the solution gave, by spontaneous evaporation, a quantity of prismatic crystals, having the appearance and all the properties of sulphate of magnesia. By subtracting from the weight of the saline mass in (*e*), that of the substances afterwards separated from it, we get 3 grains for the amount of the sulphate of magnesia*.

(*i*) 3 cubic inches of the water were precipitated by muriate of baryta. The sulphate of baryta after ignition weighed 67.32 grains, equivalent to 22.82 grains of sulphuric acid.

(*k*) 3 cubic inches of the water were precipitated by ammonia, and the liquid filtered and concentrated by heat to nearly one-third of the original bulk. Sulphate of silver was then added, which caused a slight muddiness, but no immediate precipitate. In two or three days a little chloride of silver had fallen, which was collected and ignited. It then weighed .05 grain, equivalent to .0126 of muriatic acid.

In 3 cubic inches of the Vicar's Bridge water we thus have,

Oxide of iron, *(b)* and *(e)*, . . .	16.66
Alumina, *(c)*	1.95
Magnesia, *(h)*	1.
Lime, *(d)*	.195
Soda and potash,† *(g)* . . .	·014
Sulphuric acid, *(i)*	22.82
Muriatic acid, *(k)*	.012
	42.651

* I have thought it unnecessary in making the deduction to compute the residue of .03 in *(g)* as a sulphate, because it still retained a trace of deliquescent matter, and also a minute quantity of alkaline sulphate, which had escaped decomposition by the barytic salt.

† For the reason stated in the above note, I have thought it better to compute the amount of the soda and potash from the quantities necessary to saturate the muriatic acid, with which they were plainly in combination, than from the residue of .03 grains taken as chlorides. The variation is not greater than about .005.

Of these constituents the muriatic acid is saturated by the alkalies. The other bases are therefore united to sulphuric acid; and after saturating the alumina, magnesia and lime, there remain 16.209 of sulphuric acid, which must be united with oxide of iron. This quantity, it will be observed, is nearly equal to that of the oxide of iron itself. The iron, it appears from the action of reagents which I have detailed in a former part of the memoir, must be partly in the state of peroxide, and partly in that of protoxide; the former, however, constituting considerably the larger proportion, as is evident from the colour of the water and from the effects of these reagents. I think it most probable, that, when the water is in a quite fresh state, the base is the black oxide of iron, or, more correctly speaking, the constituent atoms of that oxide, which are 2 atoms of peroxide + 1 atom of protoxide; and that the salt has arisen from the gradual and partial peroxidation of a protosulphate of iron. Indeed, many of the leading characters of the water are those given by Gay Lussac* and Berzelius† as belonging to a solution of the black oxide in sulphuric acid. Such are the dark precipitate with ammonia, the fine blue with nutgalls and ferro-prussiate of potash, and even the natural colour of the water. Supposing this oxide to exist in the water, the ratio of the base to the acid, it would appear, ought to be as 14.5 (2 at perox. + 1 at protox) : 15 (3 at sulphuric acid).‡

* Annales de Chimie, lxxx, 166.

† Lehrbuch der Chemie, ii. 735.

‡ Berzelius (Lehrbuch der Chemie, ii. 736) has described a red salt found in the copper-mine of Fahlun, in Sweden, the constitution of which, both as regards the nature of the base, and the relative proportions of base and acid, seems to have been analogous to that of the salt of iron contained in the Vicar's Bridge water. It occurred in the form of large stalactites, composed of small transparent crystals, and mechanically mixed with sulphate of magnesia. Berzelius states, that he found the base of this salt to be the black oxide of iron (eisen oxyd oxydul), and the acid to contain twice the oxygen of the base. It would seem, however, that the combination could not have been in atomic proportion, if the base was strictly the ferrosoferric oxide and if the oxygen of the acid was *exactly* twice that of the base. The nearest approach to that ratio in an atomic combination would be 9 : 4. This is the ratio of the oxygen of 3 atoms sulphuric acid to the oxygen of 1 atom protoxide, + 1 atom peroxide, which is Berzelius' view of the constitution of

In this view, therefore, the oxide of iron actually found is a little in excess, a circumstance which may, to a certain extent, be owing to partial peroxidisement of the ammoniacal precipitate, by exposure to air. In proportion as we assume the relative quantity of protoxide in the water to be less than that in the black oxide, the ratio of the base and acid will approach more nearly that of equality. When the water was evaporated to the consistence of a sirup, I found that alcohol took up hardly any of the residue. Neither did it cause, when added to the water, any precipitation of protosalt,—circumstances which may perhaps arise from some degree of chemical union existing between the salt of iron and the sulphate of alumina, and interfering with the solubility of the persalt in alcohol.

Were we to assume the peroxide to be the true base, and the protoxide to be accidental or insignificant in quantity, the salt would then be a persulphate, composed of 1 atom base + 1 atom acid. But the common red persulphate of iron is well known to be a sesquisalt.

I shall content myself in the circumstances, with simply uniting the quantities of oxide and acid actually found, which cannot, in any view, give a result very far from the truth.

In 3 cubic inches of the water we thus have,—

Persulphate and protosulphate of iron, .	32.869
Sulphate of alumina	6.283
Sulphate of magnesia . . .	3.
Sulphate of lime, ...	.473
Common salt and muriate of potash, . . .	.026
	42.651*

An imperial pint of 34.659 cubic inches of the Vicar's Bridge water therefore contains,

the *eisen oxyd oxydul*, his atom of peroxide being twice the weight of that of Dr Thomson. The salt contained water of crystallization, and was soluble in that liquid; and as it was accompanied by sulphate of magnesia, its solution would, in that respect, also resemble the water under consideration. It of course proceeded from the decomposition of pyrites of the mine.

* 3 cubic inches of the water weigh about 814 grains. Hence about 19 parts of it contain 1 of solid matter; or it contains more than 5 per cent. of solid matter. Sea water contains about 3 per cent. saline constituents.

Persulphate and protosulphate of iron, . .	379.73
Sulphate of alumina, ...	72.58
Sulphate of magnesia, . . .	34.65
Sulphate of lime, . . .	5.46
Common salt and muriate of potash, .	.3
	492.72

And an imperial gallon contains,—

Persulphate and protosulphate of iron, . .	3037.84
Sulphate of alumina, ...	580.64
Sulphate of magnesia, ...	277.20
Sulphate of lime, ...	43.68
Common salt and muriate of potash, . .	2.4
	3941.76

There seems little doubt that this water proceeds from the decomposition of some description of shale in the vicinity of its site. Whether the shale in which it is actually found is capable of affording its constituents by disintegration, I do not know, not having yet obtained any specimens of it. Both proper alum-slate, and various shales of the coal-formation, afford, as is well known by decomposition, saline products appearing sometimes as solutions, and sometimes as crystallized salts.*

* Dr Thomson has analyzed a chalybeate from the neighbourhood of Moffat, somewhat analogous to the present in composition, although greatly inferior in strength, and which he conceives to proceed from decomposed alum-slate (Glasc. Med. Jour. i. 129). Its specific gravity was 1.00965. Its colour red. In an imperial gallon it contained,

Persesquisulphate of iron, .	591.025
Sulphate of alumina, . .	112.756
Sulphuric acid in excess, . .	5.202
	708.953

The hair salt of the coal-strata of the neighbourhood of Glasgow was found by Dr Thomson (Hist. of Chemistry, p. 104) to consist of,

1 atom protosulphate of iron,
1½ atoms sulphate of alumina,
15 atoms water,

Constituting a kind of alum. Its solution in water would afford an aluminous chalybeate, which by exposure to air would become more or less peroxidized, unless the chemical union of the salts of iron and alumina should prevent that process.

Observations on the History and Progress of Comparative Anatomy. By David Craigie, M. D., &c. (Continued from page 162.)

Section II.—*The Middle Ages to the Revival of Literature.*

The death of Galen, which took place at Pergamus in the 90th year of his age, and 193d year of the Christian era, may be regarded as the downfall of anatomy in ancient times. After this period are recognised scarcely more than three names deserving mention in the history of anatomical science, those of Oribasius, the friend and physician of the Emperor Julian the apostate, Theophilus, chief of the imperial guard of Heraclius, and Meletius a monk, the author of a treatise *De Natura et Structura Hominis.*

The unsettled state of society during the latter ages of the Roman Empire, was extremely unfavourable to the cultivation of science. The weakness and decrepitude of the imperial administration after its transference to the East, demonstrated by the formation of turbulent factions, diverted the attention of mankind from literature and philosophy to the more brilliant game of ambition and political intrigue. Even the introduction of Christianity, by condemning to execration all the monuments of pagan genius, appears to have exercised a pernicious influence on the progress of science; and the sanguinary persecutions of which it was made the pretext, tended in the most remarkable manner to extinguish science, and embitter the existence of its few remaining votaries. The Christian sect distinguished by the name of Nestorians, had signalized themselves in the course of the 5th century by the cultivation of philosophy and medicine; and had founded a school at Edessa, taught by able instructors, and among others a physician named Stephen, well known as the medical adviser of Haroun al Raschid. To these unlucky enthusiasts, however, the rigid orthodoxy of Theodosius II., Zeno the Isaurian, and Justinian, proved fatal; and they were compelled, after much persecution, to abandon Edessa. From the 5th to the 8th century, the empire, divided by internal discord, and assailed on every side by the rude barbarians of the east and north, presents a scene of ignorance, crime, and barbarism, utterly incompatible with the cultivation of science; and the knowledge possessed by a few scholars was scarcely sufficient to enable them to write bad memoirs of the passing events. In such a state of society, when the art of healing professed by ecclesiastics and itinerant practitioners was degraded by the grossest ignorance and superstition, it is not wonderful that anatomy was entirely neglected, and that no name of anatomical celebrity occurs to diversify the long and uninteresting period commonly distinguished as the middle ages.

Nor can the anatomists look to the Arabian physicians and naturalists during this period with better hopes of success. Though several of the learned Saracens eagerly cultivated the knowledge of natural history, though they were anxious to discover the virtues of various plants, studied alchemy, and made several bold experiments on the human frame by the earthy or metallic salts, anatomy was never cultivated practically by them, and the little knowledge which they possessed was derived from the writings of Aristotle and Galen. The Koran denounces as unclean the person who touches a corpse, human or animal; the precepts of Islamism forbid dissection; and however distinguished in medicine were Al-Rasi, Ibn-Sina and Ibn-Rosch, the Razes, Avicenna, and Averrhoes of European authors, these prejudices prevented them from acquiring the most important and fundamental principles of their science. Abdollatiph alone, the annalist of Egyptian affairs, admits the necessity of personal dissection. But the influence of a single individual is of little avail in stemming the torrent of national prejudice. It is a singular proof of the pernicious influence of reputation, nevertheless, that the nomenclature and distinctions of the Arabians were long retained by European anatomists, till the revival of ancient learning restored those of the Greek physicians. Thus the *cervix* or nape of the neck is denominated *nucha*; the *diaphragm* is named *meri*; the umbilical region, *sumen* or *sumach*; the abdomen, *myrach*; the peritoneum, *siphac*; and the omentum *zirbus*.

The Saracens were indebted for their literary and scientific celebrity not to their merit, but to the ignorance and comparative rudeness of the Europeans. As soon as the wealth and independence of the Italian States created a love of knowledge schools and academies rose among them in rapid succession; and the Arabian teachers and writers, though long after quoted, began gradually to be neglected and forgotten. Among the new European Institutions, that of Bologna, already celebrated as a school of literature and law, became no less distinguished in the thirteenth century for its medical teachers. At the commencement of the fourteenth century especially, it was fortunate enough to possess in Mondino de Luzzi a teacher under whose auspicious zeal anatomical science was destined to rise from the ashes in which it had been buried. By demonstrating the parts of the human body in two female subjects in the year 1315, and repeating this course of instruction on the body of a single female in the course of the following year, Mondino has obtained the distinction of being the founder of true anatomical knowledge in modern times. Though his name is more closely connected with human than with animal anatomy, it is nevertheless important in marking an era in the history of the science. The greatest defect which he shews in common with the writers of these times, is his servile attachment to Galen and the Arabians, by whose exotic nomenclature his descriptions are defaced. He died, according to Tiraboschi, in 1325.

Mondino divides the body into three cavities (*ventres*), the upper containing the animal members, as the head; the lower containing the natural members; and the middle containing the spiritual members. He first delivers the anatomy of the lower cavity or the abdomen, then proceeds to the middle or thoracic organs, and concludes with the upper, comprising the head, and its contents and appendages. His manner is to notice shortly the situation and shape or distribution of organs, and then to mention the disorders to which they are subject. The peritoneum he describes under the name of *siphac*, in imitation of the Arabians, the omentum under that of *zirbus*, and the mesentery or *eucharus* as distinct from both. In speaking of the intestines, he treats first of the rectum, then the colon, the left or sigmoid flexure of which, as well as the transverse arch and its connection with the stomach, he particularly remarks; then the *cæcum* or *monoculus*; after this the small intestines in general, under the heads of *ileum* and *jejunum*; and latterly, the duodenum; making in all six bowels. The liver and its vessels are minutely, if not accurately examined; and the *cava* under the name *chilis* a corruption from the Greek κοιλη, is treated at length, with the emulgents and kidneys. His anatomy of the heart is accurate, and it is a remarkable fact, which seems to be omitted by all subsequent authors, that his description contains the rudiments of the circulation of the blood. "Postea vero versus pulmonem est aliud orificium venæ arterialis, quæ *portat* sanguinem ad pulmonem, a corde; quia cum pulmo deserviat cordi secundum modum dictum ut ei recompenset, cor ei *transmittit* sanguinem per hanc venam, quæ vocatur vena arterialis, et vena quæ portat sanguinem, et arterialis, quia habet duas tunicas; et habet duas tunicas, primo quia vadit ad membrum quod existit in continuo motu, et secundo quia portat sanguinem valde subtilem et cholericum." The merit of these distinctions, however, he afterwards destroys by repeating the old assertion, that the left ventricle ought to contain spirit, which it generates from the blood.

His osteology of the skull is erroneous. In his account of the cerebral membranes, though short, he notices the principal characters of the *dura mater*. He describes shortly the lateral ventricles, with their anterior and posterior *cornua*, and the choroid plexus as a blood-red substance, like a long worm. He then speaks of the third or middle ventricle, and one posterior, which seems to correspond with the fourth; and describes the infundibulum under the names of *lacuna* and *emboton*. The inferior recesses he appears to have omitted. In the base of the organ he remarks, first, two mammillary caruncles, the origins of the olfactory nerves, which, however, he overlooks; the optic nerves, which he reckons the first pair; the oculo-muscular, which he accounts the second; the third, which appears to be the sixth of the moderns; the fourth; the fifth, evidently the seventh; a sixth, the *nervus vagus*; and a seventh, which is the ninth of the moderns.

Notwithstanding the misrepresentations into which this early anatomist was betrayed, his book, which has been illustrated by the successive commentaries of Achillini, Berenger, and Dryander, is valuable, and formed for at least a century the textbook of all the anatomical schools.

Mathew de Gradibus, a native of Gradi, a town in Friuli near Milan, and Professor of Medicine at Pavia, distinguished himself by composing a series of treatises on the anatomy of various parts of the human body. He is the first who applies the name of *Ovaries* to the ovoidal bodies placed in the folds of the broad ligaments of the female uterus, and considers them as receptacles of ova. This opinion Steno afterwards adopted without acknowledgment.

Similar objections to those already urged in speaking of Mondino, apply to another anatomist of these times. Gabriel de Zerbis, who flourished at Verona towards the conclusion of the fifteenth century, is the author of a system, in which he is more anxious to astonish his readers, by the wonders of a verbose and complicated style, than to instruct by precise and faithful description. He recommends the dissection of animals, and especially the monkey. He is superior to Mondino in knowing the *olfacient nerves*, and he recognises the vascular structure of the testicles.

Eminent in the history of the science, Alexander Achillini of Bologna, the pupil and commentator of Mondino, appeared at the close of the fifteenth century, and, as Professor of Medicine in that University, attracted by his celebrity numerous students from every part of the world. Though a follower of the Arabian school, the assiduity with which he cultivated anatomy has rescued his name from the inglorious obscurity in which the Arabesque doctors have in general slumbered. He is known in the history of anatomical discovery as the first who described the two tympanal bones termed *malleus* and *incus*. In 1503, he shewed that the tarsus consists of seven bones; he rediscovered the *fornix* and *infundibulum*; and he was fortunate enough to observe the course of the cerebral cavities into the inferior *cornua*, and to remark peculiarities to which the anatomists of a future age did not advert. He mentions the orifices of the ducts afterwards described by Wharton. He knew the ileo-cæcal valve; and his description of the duodenum, ileum, and colon, shews that he was better acquainted with the site and disposition of these bowels than any of his predecessors or contemporaries. By representing the *urachus* to be hollow, he shews that he had examined it only in the foetus of the lower animals.

Immediately after, the science boasts of one of its most distinguished founders. James Berenger of Carpi, in the Modenese territory, was professor of anatomy and surgery in the university of Bologna. His first course, he is represented by

Sprengel to have delivered, in 1502, in the palace of Albert Pio, lord of Carpi, on the body of a pig. From the testimony of Tiraboschi, however, it appears that this could scarcely be denominated a course of anatomical lectures. Albert Pio, who was at once one of the most learned men, and the most liberal patrons of science of the day, had formed the resolution of studying anatomy; and as this could be done, in these times, on the bodies of pigs only, he availed himself of the assistance of Berenger, who, as the son of a surgeon of Bologna, was known to be adequate to the task. It appears, therefore, to have been merely a course of private demonstrations to Pio and some of his friends. Afterwards, however, Berenger, who appears to have had a decided taste for anatomy, cultivated the art with extreme assiduity; and though professor of surgery in the University of Bologna, occupied himself mostly with dissection. Though unlike his predecessors and contemporaries he dissected few animals, he was most assiduous in the study of the structure of the human frame, and he declares that he dissected above an hundred bodies. He is the author of a compendium, of several treatises which he names introductions (*Isagogae*), and of commentaries on the treatise of Mondino. Like him, he is tinged with the mysticism of the Arabian doctrines; and though he employs the Grecian nomenclature in general, he never forgets to give the Arabian terms, and often uses them exclusively. In his commentaries on Mondino, which constitute the most perspicuous and complete of his works, he not only rectifies the mistakes of that anatomist, but delivers minute, and, in general, accurate anatomical descriptions.

He is the first who undertakes a systematic view of the several textures of which the human body is composed, and in a preliminary commentary he treats successively of the anatomical characters and properties of fat, of membrane in general (*panniculus*), of flesh, of nerve, of *villus* or fibre (*filum*), of ligament, of sinew or tendon, and of muscle in general. He then proceeds to describe with considerable precision the muscles of the abdomen, and illustrates their site and connections by wooden cuts, which, though rude, are spirited, and show that anatomical drawing was in that early age beginning to be understood. In his account of the peritoneum, he admits only the intestinal division of that membrane, and is at some pains to prove the error of Gentilis, who justly admits the muscular division also. In his account of the intestines, he states the length of the canal to be 13 Bologna ells: he is the first who mentions the vermiform process of the cæcum; he remarks the yellow tint communicated to the jejunum by the gall-bladder; and he recognises the opening of the common biliary duct into the duodenum (*quidam porus portans choleram*). In the account of the stomach, he describes the several tissues of which that organ is composed, and which, after Almansor, he represents to be three, and a fourth from the peritoneum; and afterwards notices the *rugæ* of its villous surface. He is at considerable pains to explain the organs of generation, and recognises the communication of the arteries and veins in the body of the testicle. In his account of the anatomy of the fœtus, which is long and minute, he allows only one umbilical vein, and represents the *urachus* as an impervious chord, evident proofs that he had compared them with the fœtus of the lower animals. He was the first who recognised the larger proportional size of the chest in the male than in the female, and conversely the greater capacity of the female than of the male pelvis. In the larynx he discovered the two arytenoid cartilages. He gives the first good description of the thymus, distinguishes the oblique situation of the heart, describes the pericardium, and maintains the uniform presence of pericardial liquor. He then describes the cavities of the heart; but perplexes himself, as all the anatomists of that age, about the spirit supposed to be contained. The aorta he properly makes to arise from the left ventricle; but confuses himself with the *arteria venalis* (pulmonary vein) and *the vena arterialis*, the pulmonary artery; and he further demonstrates the existence and operation of the tricuspid valves in the right ventricle, and of the sigmoid valves at the beginning of the pulmonary artery and aorta, and allows only two ventricles separated by a solid impervious *septum*. His account of the brain is good. He gives a minute and clear description of the ventricles, remarks the *corpus striatum*, and has the sagacity to perceive that the choroid plexus consists of veins and arteries; he then describes the middle and third ventricle, the infundibulum or *lacuna* of Mondino, and the pituitary gland; and lastly, the passage to the fourth ventricle, the conarium or pineal gland,

and the fourth or posterior ventricle itself, the relations of which he studied accurately. He rectifies the mistake of Mondino as to the olfactory or first pair of nerves, gives a good account of the optic and others, and is entitled to the praise of originality in being the first observer who contradicts the fiction of the wonderful net (*rete mirabile*), and indicates the principal divisions of the carotid arteries. He enumerates the tunics and humours of the eye, and gives an account of the internal ear, in which he notices the *malleus* and *incus*.

While Berenger was thus advancing the interests of true anatomical knowledge in Italy, it is a singular example of the slowness with which knowledge was diffused at that time, that the naturalists and physicians of France and other countries, were in the most profound ignorance of the progress of the Italian anatomists, and betrayed the most supine indifference to the brilliant career of their Cisalpine neighbours. Paris indeed appears at this time to have possessed one anatomist, who, with suitable means, had both the capacity and the desire to improve the science. But the prejudices against the dissection of the human body prevented him from availing himself fully of the information which he derived from the animals which he dissected; and John Gonthier of Andernach is chiefly distinguished as a teacher, in whose school some of the first anatomists of the succeeding age had acquired the elements of the science. In this school Vesalius, Eustachius, and Fallopius, afterwards so celebrated in the history of Italian anatomy, studied; it is believed, with some probability, that from Gonthier, Rondelet derived his taste for animal anatomy; and the circumstance of his being the instructor of Michael Servet, whom he ranked next to Vesalius as an anatomist, is sufficient to entitle him to an honourable place in the history of anatomy. He seems to have dissected few human bodies, and to have confined his researches chiefly to those of the lower animals; and in the course of these he appears to have recognised the glandular body placed in the middle of the mesentery of carnivorous animals, and which he erroneously named *pancreas*. It has been since distinguished by the name of *pancreas Asellii*.

From the time of Mondino, Achillini, and Berenger, who were professors in the University of Bologna, the rise of the

Italian school of anatomy may be dated. The celebrity of their teachers gave Bologna a degree of pre-eminence which she retained for ages, and which was well supported by the talents of Vesalius, Arantius, and Varoli.

The appearance of Mondino and Berenger exercised a most favourable influence on anatomy, both human and animal. Previous to their time, the practice of teachers was to deliver obscure, unintelligible, and often imaginary accounts of the parts of the human body, with commentaries on the descriptions of Galen, and illustrations derived from the bodies of dogs, pigs, and the common domestic animals. Even Berenger, as we have seen, though professor at Bologna, is recorded to have delivered his first course of anatomy on the body of a pig, in the house of Albert Pio, lord of Carpi. Of this unpropitious system of instruction, the effect was to distort and misrepresent human anatomy, while animal anatomy was cultivated on so limited a scale, and with such perverted objects, that, instead of utility, it was productive of much injury. By removing the superstitious prejudice against dissecting human bodies, the true structure of the human frame began to be better understood and more diligently studied; and curiosity prompted anatomists to enlarge their conceptions of animal structure by the comparative inspection of the same organs in the lower animals. In this manner Michael Angelo Buonarotti, the celebrated painter, dissected both human and animal bodies, and compared the position and relations of the muscles in both; and, at a subsequent period, we shall find that Rondelet, Coiter, Aldrovandus, and Fabricius ab Aquapendente, applied it in this manner with the happiest effects.

In France, the prejudices against the dissection of the human body were so strong, that although permission to dissect the human subject had been granted at Montpellier in 1376, there is no proof that it had come into general use for more than a century and a half after that period. It is, indeed, one of the charges of Vesalius against Dubois, that a human body was never seen in his theatre; that the carcasses of dogs, and other animals, were the materials from which he taught; and that, unless Vesalius and his fellow-students had assiduously collected human bones from the Innocents and other cemeteries, they must have been unable to acquire the first principles of the science. Though Dubois is represented by Riolan to have the merit of being the first to dissect the human body in France, his conduct and general character give confirmation to several of the charges of Vesalius. A bigoted and indiscriminate admiration of the works of Galen made him substitute the interpretation of the descriptions of that author for actual demonstration; and it is easy to trace some of the bold contradictions with which he wished to overwhelm Vesalius to his confidence in Galen, in opposition to truth, and to his jealousy of the rising talents of that anatomist. This conduct was extremely pernicious both to human and to animal anatomy; and when it was afterwards seen that Vesalius was in the right, the reputation of Dubois suffered, and the dissection of dogs and pigs became the subject of ridicule and contempt. On this account, the few observations which Dubois made on the ligaments of the colon in the ape and other animals, possess little value.

A much more honourable character is due to Charles Etienne, a younger brother of the celebrated printer, and son to Henry, who latinized the family name by the classical appellation of Stephen (Στεφανος). Though sprung of a family whose classical taste has been their greatest distinction, Etienne cannot be charged with the servile imitation of the Galenian anatomy which Dubois betrays. This originality enabled him to recognise the interarticular fibro-cartilages of the temporo-mammillary and femoro-tibial articulations, several of the ligaments, the valves of the veins, which he denominates *apophyses venarum*, and to distinguish the pneumogastric nerve from the great sympathetic. Though his knowledge of the brain is inferior to that of Achillini, his researches into the structure of the nervous system are neither unprofitable nor inglorious; and the circumstance of demonstrating a canal through the spinal chord, which has escaped the notice not only of his contemporaries, but his successors, till M. Senac made it known, is sufficient to entitle him to a respectable place among the list of anatomical observers. He is not much known as an animal anatomist; but the fact now mentioned shows that he dissected the lower animals, in which only, and in the human fœtus, this canal is distinct.

It is painful to think that so much merit was unable to afford

Etienne immunity from the fanatical severity of the times. His tranquillity was disturbed, and his pursuits interrupted by the oppressive persecutions in which their religious opinions involved the family; and Charles Etienne drew the last breath of a miserable life in a dungeon in 1564.

While anatomical science was in this languid state in France, a great revolution was effected in its favour by the exertions of a young Fleming, whose appearance forms a conspicuous era in its history. Andrew Vesalius, a native of Brussels, after acquiring at Louvain the ordinary classical attainments of the day, began at the age of 16 to study anatomy under the auspices of Dubois. Common sense quickly taught him that little anatomical knowledge was to be obtained from the commentaries of Galen, and the dissection of dogs and pigs only; and the difficulties with which the cultivation of human anatomy was encompassed in France, made him look to Italy, which Mondino, Achillini, and Berenger had already rendered distinguished; and in 1536 we find him at once zealously pursuing the study of human and animal anatomy, and requested, ere he had attained his 22d year, to demonstrate publicly in the University of Padua. After remaining here about seven years, he went by invitation to Bologna, and soon after to Pisa; and Vesalius, thus professor in three universities, appears to have carried on his anatomical investigations and instructions alternately at Padua, Bologna, and Pisa, in the course of the same season. On this account Vesalius, though a Fleming by birth, and trained very early in the French school, belongs as an anatomist to the Italian, and forms one of that illustrious line of teachers, by whom the anatomical reputation of that country was in the sixteenth century raised to the greatest eminence.

Of the services of this distinguished anatomist it is impossible in this short sketch to communicate an accurate idea. Though Mondino and Berenger preceded him in teaching anatomy from the human subject, and in publishing treatises derived from personal observation, Vesalius is entitled to the merit of composing the first comprehensive and systematic view of human anatomy. By his enemies he was accused of undue reverence to Galen, and departing most widely from the method and description of that anatomist. But at present we are rather sorry that he departed so little, and that on every occasion he finds it requisite to make apologies for dissenting from the oracle of antiquity.

Besides the general accuracy which he has introduced into anatomical description, he verified the observation of Etienne on the valves of the hepatic veins, described the *vena azygos*, and discovered the canal which passes in the fœtus between the umbilical vein and *vena cava*, since named the *ductus venosus.* He described the omentum, and its connexion with the stomach, spleen, and colon; gave the first correct views of the structure of the *pylorus*; remarked the small size of the cæcal appendix in man; gave a good account of the *mediastinum* and *pleura*; and the most complete description of the anatomy of the brain yet advanced. He appears, however, not to have understood the inferior recesses; and his account of the nerves is confused by regarding the optic as the first pair, the fifth or trigeminal as the third, and confounding the seventh or lateral facial, and the eighth or auditory, under one head as the fifth.

Though the efforts of Vesalius were in the highest degree favourable to the cultivation of human anatomy, they tended to throw discredit and contempt for some time on animal anatomy, which was henceforward either abandoned or pursued only in a languid and ineffectual manner. The example of Vesalius was indeed followed by numerous emulous competitors for distinction, some in Italy, others in France. In 1543, Cannani of Ferrara published his valuable engravings, and contributed to rectify the notions of anatomists on the muscles. Osteology at the same time found an assiduous cultivator in John Philip Ingrassias, a Sicilian physician, who, in a learned commentary on the osteology of Galen in 1546, corrected numerous mistakes, and gave several accurate descriptions from the natural objects. Of these his accounts of the sphenoid and ethmoid bones are excellent examples; and if Eustachius and Fallopius at the same time described the third tympanal bone termed *stapes*, the latter candidly allows to Ingrassias the merit of discovery. He knew also the mastoid cells, the two *fenestræ*, the *chorda tympani*, the semicircular canals, and the *cochlea.* For this minute acquaintance with the organ of hearing, and especially for the discovery of the stapes, Ingrassias acknowledges he was indebted to his dissection of the heads of oxen and other large animals. After he had discovered the bone in these, he recognised it in the tympanum of the human body.

In the mean time, the city of Montpellier had the honour of possessing a physician who set the first example of the systematic application of zootomy in modern times to illustrate and rectify zoological knowledge. Trained in the school of Gonthier, from whom probably he imbibed his love of animal anatomy, and deeply read in the writings of Aristotle, Athenæus, and Oppian, William Rondelet, though bred to the profession of medicine, manifested the greatest zeal for acquiring an accurate knowledge of the structure and peculiarities of animals. Yet the philosophical reader may be surprised to find that the individual who had judgment enough to undertake to illustrate zoology by means of zootomy, and who is further distinguished as the founder of the anatomical theatre of the University of Montpellier, could be deemed a meet subject for the buffoonery of Rabelais. Aristophanes had the talent to exhibit to the ridicule of the Athenians, the only individual to whose philosophical instructions they were indebted for forming two of the ablest characters of whom their history can boast. The Aristophanes of the sixteenth century, though endowed with a coarser vein, had ingenuity enough to amuse his readers, by exhibiting, under the fictitious name of *Rondibilis*, an anatomist and zoologist, whose services to science must convey a very contemptible opinion both of the author of this foolish piece of humour, and of those to whose amusement it contributed. What rendered this ridicule so much less justifiable, if ridicule can in any circumstances be defended, is, that Rondelet appears to have been a quiet inoffensive person, too assiduously and exclusively devoted to his professional and scientific pursuits, to provoke the spleen or displeasure of any one.

Rondelet appears to have been rather unsuccessful in early life; and it is recorded that Botegari, a wealthy Italian, who had married the sister of his wife, and whose marriage was childless, shared with him his property during life, and bequeathed to him the residue after death. A more honourable, if not more desirable circumstance was, that the Cardinal de Tournon soon after appointed him his physician; and the frequent journeys which Rondelet had in this capacity occasion to perform into Italy, enabled him to spend much of his time in that country, and to procure much of the zootomical and zoological information with which his History of Fishes abounds. It appears even that his subsequent appointment (1565) to the professorship of medicine in the University of Montpellier, did not prevent him from attending the Cardinal, and collecting materials for zoology and zootomy.

The principal work of Rondelet is his Natural History of Fishes, published at Lyons in 1554, in eighteen books; and it is valuable in giving not only the zoological, but much of the anatomical history of these animals. The first four books of this work are devoted to the explanation of the principal external and anatomical characters of fishes. In the eleven succeeding ones he describes more than 200 species of fishes, and though in the number of *genera* several changes have taken place since his time, he has described at least 120. The sixteenth book contains an account of three species of turtle, and an interesting sketch of the cetaceous and amphibious *mammalia*; and in the seventeenth he describes several genera of *mollusca* and *crustacea*.

From this arrangement of his subject, it may be seen that Rondelet employs the term *fish*, in a sense too extensive; and indeed he seems to have included under this denomination every living inhabitant of the waters. It would be unjust, however, to his anatomical knowledge, to represent him as confounding them all under one general head. He has drawn an accurate and distinct line between the fishes properly so named, or those which breathe by gills, and the ichthyoid or fish-like animals, which breathe by lungs; and he repeatedly takes occasion to point out the resemblance between the anatomical structure of the latter and that of the other *Mammalia*.

It would lead me much beyond the limits within which I must confine this sketch, were I to give even a general account of the valuable researches of Rondelet. A few points only, which may shew his talent for observation, I shall specify. In the first nine chapters of the third book, he considers the general characters of the head, eyes, ears, mouth, snout, jaws, teeth, nostrils and lips, and tongue and palate. He then examines the windpipe and lungs, and observes that their place is supplied by gills which are pervious to air and water, yet exclude the latter while they admit the former. That this mode of respiration is connected with the small proportion of blood and the lower temperature, he infers from the fact, that aquatic animals which are warm and abound in blood, as the dolphin, seal, and whale, respire the air by means of genuine lungs; and he adds, that in those which have gills, the swimming bladder is perhaps calculated to answer a similar purpose. He then describes the distribution of the bronchial tubes in man, land animals, and the fishes which breathe by lungs; in other words, in the *Mammalia*; in all which he takes care to say the structure is the same, with this exception, that, in the *Cetacea* and *Amphibia*, the lung is not so soft and spongy as in the terrestrial *Mammalia*, but is thick and fleshy, probably because the occasional admission and expulsion of the water required such a peculiarity. Gills, on the other hand, are peculiar to fishes; and of these some are covered, as in the species of *lupus* or pike; the *aurata*, a species of dory; the *scari*, *cynaedi*, and tunny (*thynni*); *xiphias*, sword-fish; the sea-pike or spit-fish (*sphyræna*), &c.; while others, as all the cartilaginous fishes, except the sturgeon, are uncovered. He also remarks the tubular gills, or branchial perforations of the lamprey, eel, and similar fishes, and rectifies the mistake of Pliny, who asserts that the *muraena*, a species of lamprey probably, is void of gills. The heart he distinguishes into three parts, an inferior, a middle, evidently the ventricle, and the superior, which is manifestly the bronchial artery, and which he properly represents to be an arterial tube (αγγειον αρτηριωδες).

In the alimentary canal he recognises the longitudinal and transverse folds of the gullet, and the peculiarities of the stomach in shape and size. Those of the mullet and sturgeon he accurately represents to be fleshy and muscular. The pyloric or duodenal appendages also, he remarks, vary in number, and are confined to those which have gills. He rather ingeniously observes, on the use of these bodies, that, as the temperature of fishes is low, the food distributed into these appendages may be more readily acted on than if it was in one cavity.

The want of genuine kidneys and a bladder, he remarks in proper fishes, birds and reptiles. Those which breathe by lungs, however, that is, the cetaceous and amphibious animals of modern zoology, for instance the whale, physeter, orc, seal, dolphin and turtle, have organs of this description. Those of the seal, he observes, are similar to those of the wolf, that is, consist of several kidneys and several lobules, as in the human fœtus and infant. Those of the dolphin and otter he compares to a cluster of conglobate or aggregated lobes. In speaking of the bladders of genuine fishes, he remarks, that in river fishes, and some sea fishes, there is one filled with air between the spine and peritoneum, evidently referring to the air-bladder.

In describing the organs of generation, he still observes an accurate distinction between the cetaceous and genuine fishes. In the former, for instance, the dolphin, seal, and whale, there are *testes* and *penis*, the former oblong, roundish, and contained within the abdomen; while the females have *uterus*, *vagina* and *mammæ*. In genuine fishes, however, which are void of proper *testes*, their place is supplied by two long canals (*meatus*), suspended from the diaphragm on each side of the spine, meeting in one canal, and opening in the common outlet for the excrements, or what is now denominated the *cloaca*. He mentions also the periodical enlargement of these bodies, which manifestly correspond with the milt or soft roe. Under the name of *Galeus acanthias* and *Galeus laevis*, he describes two species of ovoviviparous sharks, gives a distinct account of their uterine cavities, and of the mode in which the young are reared within the body of the parent, and delineates a large specimen of the latter, with one young one adhering to it by the umbilical vessels. "Galei qui laeves vocantur," he says, "ova in media vulva gestant, ut caniculae, quae postea in utrumque uteri sinum descendunt; mox animal gignitur, umbilico haerente ad vulvam, ita ut ovo absumpto partus non aliter quam in quadrupedibus contineri videatur. Adhæret umbilicus ille prolixus capite altero ad partem vulvae inferiorem velut ex acetabulo annexus, altero ad medium foetum qua in parte jecur est. Nos foetum cum umbilico matri adhaerente pingendum curavimus, et a caniculis, vulpibus, aliisque galeis discerneretur, cum nullus ex galeis alius sit cujus foetus secundis membranisque involvatur, uteroque matris per umbilicum alligetur." *De Piscibus*, lib. xiii. cap. iii. The several species of this genus which correspond to the *Selachides* of Cuvier, Rondelet represents with characteristic accuracy; and even the branchial slits are well exhibited. The same may be said of the tubular openings of the lamprey and congenerous fishes.

The 16th book on the cetaceous fishes and amphibia, contains much accurate and interesting anatomical information. Rondelet is chiefly known as an animal anatomist. From his descriptive statements in this book, however, especially that of the dolphin, it appears that he knew the *vesiculae seminales* not only in that animal but in man. He gives a particular account of the alimentary canal and its appendages, the kidneys, ureters, and bladder, and the reproductive organs generally; and in the course of description, compares the organs with those of man and the hog, clearly shewing that he was quite aware of the difference between the dolphin and genuine fishes. "Sub peritonaeo partes quae ad nutritionem et generationem imformatae sunt ad quadrupedum *terrestrium* magis quam ad piscium partes accedunt."

Rondelet also knew the true structure of the follicles in the beaver, and the sebaceous mucous glands of the *anus* in birds and hares. Achillini, I have already mentioned as the first discoverer of the ileo-caecal valve, which is now invariably designated by the name of Caspar Bauhin. I must not omit to remark, however, that Rondelet had discovered this membranous duplicature, independent of any knowledge of its existence from Achillini; and that to Rondelet, his pupil Posthius, whose name has also been associated with this valve, was indebted for his knowledge of its existence.

Of this physician two circumstances are recorded, which are more creditable to his scientific zeal than his feelings or delicacy. The corpse of one of his children, cut off by disease, he is said to have caused to be inspected in the public theatre of the university; and when his colleague Fontanus was supposed to be at the point of death in a dangerous illness, Rondelet is said to have solicited him most importunately to be permitted to inspect the body of his friend when life was extinct. In the body of Fontanus, we are informed by Posthius, these anatomists examined the renal papillæ. Rondelet died of dysentery, complicated with fever, at Toulouse in 1566.

(*To be continued.*)

On Indian Hail-storms. By A. Turnbull Christie, M. D. Communicated by the Author.

In the last Number of your Journal, a new theory of hail-storms is proposed by Professor Olmsted of Yale College, viz. that they are caused by "the congelation of the watery vapour of a body of warm and humid air, by its suddenly mixing with an exceedingly cold wind in the higher regions of the atmosphere."

According to this theory it is very easy to account for those hail-storms which so frequently occur in some parts of the temperate zones, as in the south of France, or in the United States of America; for in such situations it is very possible that an intensely cold wind, proceeding from the north at a great height, might meet with a warm body of air highly charged with moisture, and thus cause a very sudden congelation, with the other phenomena that generally accompany such storms. But this explanation could not apply (even according to the Professor's own showing) to hail-storms in the torrid zone, for any two currents of air, within this zone, would differ so little in temperature, that their sudden mixture could not possibly produce congelation, but merely clouds and rain, thunder and lightning; and, says the Professor, "in this region we know not where to look for the freezing current, unless we ascend so high that there no hot air exists holding watery vapour to be frozen by it." He therefore supposes that violent hail-storms are unknown in the torrid zone, excepting in one situation, viz. in the vicinity of lofty mountains covered with snow. Here, however, he is mistaken, hail-storms being by no means uncommon in different parts of the peninsula of India, and consequently at a distance of many hundred miles from any lofty mountains *.

We are told, in Rees's Cyclopædia, that hail-storms never occur in the torrid zone; and in the Edinburgh Encyclopædia,

* The highest mountains in the peninsula of India are the Neelgherries, a small group, situated between the 10th and 11th degrees of north latitude, and having a height of little more than 8000 feet above the level of the sea, being not more than one-half of that which the snow-line would have in this situation.

under the article Physical Geography, that they never occur there, except at an elevation of not less than 1500 or 2000 feet. This I will show is by no means the case. In May 1823, a violent hail-storm occurred at Hydrabad, which is about 17° north latitude, and has an elevation (I believe) of not more than 1000 feet above the level of the sea. The hail-stones were of a considerable size, and a sufficient quantity were collected by the servants of a military mess to cool the wine for several days. A hail-storm occurred at Darwar, N. Lat. 16° 28′, E. Long. 75° 11′, in May or June 1825. The height of Darwar above the level of the sea is 2400 feet, but it is near no high range of mountains. The hail-stones had a white porous nucleus, and varied in size from that of a filbert to that of a pigeon's egg. A similar storm occurred at the same place, and about the same season, in 1826. These are the only instances of hail-storms which came under my own observation during the five years I was in India; but numerous others might be brought forward from the testimony of others. I shall only mention a few. Lieutenant-Colonel Bowler, of the Madras army, tells me that he witnessed a violent storm of hail at Trichinopoly, about the middle of the year 1805, when the hail-stones were nearly as large as walnuts. He also mentions a very violent hail-storm which occurred in the Goomsa Valley, about twenty-five miles west of Gamjam, and only a few feet above the level of the sea, when he was in camp there about the end of April 1817. It commenced about half-past three in the afternoon. The weather had previously been very sultry, with hot blasts of wind, and heavy clouds, which appeared almost to touch the tops of the tents. On the hail falling, the air became on a sudden as disagreeably cold, as it had been before oppressively hot. The same gentleman also witnessed a hail-storm at Masalapatam, on the coast of Coromandel, in 1822 (he thinks in the month of April); and others, at different times, in various parts of India.

We are told by Heyne, in his historical and statistical tracts on India, that "masses of hail of immense size are said to have fallen from the clouds, at different periods," in the Mysore country; and that, "in the latter part of Tippoo Sultan's reign, it is on record, and well authenticated, that a piece fell near Seringapatam of the size of an elephant." Of course, it is not to be expected that we are to believe this to the letter—we must make some allowance for oriental exaggeration.

It is needless to multiply examples, for I believe there is not an officer who has been many years in India, who cannot bear testimony to the frequency of hail-storms in that country. Professor Olmsted's theory, therefore, even according to his own account of it, must be abandoned; or, at all events, it will only apply to those falls of hail which occur in the temperate zones.

On the Form of the Ark of Noah.

We have a description of the Ark in the 6th chapter of Genesis; and our common translation, which is acknowledged to have given, with comparatively few exceptions, the true sense of the Hebrew and Greek originals of the Scriptures, has the following rendering of this particular passage: "Make thee an ark of gopher wood: rooms shalt thou make in the ark, and shalt pitch it within and without with pitch. And this is the fashion which thou shalt make it of: the length of the ark shall be three hundred cubits, the breadth of it fifty cubits, and the height of it thirty cubits. A window shalt thou make to the ark, and in a cubit shalt thou finish it above; and the door of the ark shalt thou set in the side thereof: with lower, second, and third stories shalt thou make it."

As, in this translation, there is no modification of the dimensions of length, breadth, and height, very obviously expressed, we are by it naturally led to conceive the form of the ark to have been a parallelopiped, of which the opposite planes are respectively equal and similar.

But there is a word in the Hebrew text, of which, there is reason to think the English translators have not apprehended the true meaning. The word is that which they have translated *window*, (in Hebrew "tzohar"), a different understanding of which will lead us to important modifications of our conception of the form of the ark.

Several commentators have supposed that this word refers rather to the peculiar form of the ark, than to any opening in it analogous to a window, without however indicating in what manner it does so; and as the word, in its singular form at least, does not again occur in the Hebrew text, to enable us to determine its true meaning by its connection with other words, it must be acknowledged there is some difficulty in investigating that meaning.

The word, in what appears to be its plural form, occurs indeed in several passages; as in Genesis xliii. 16, 1st Kings xviii. 26, and others, where its connection determines the sense to be, as it is rendered in these passages in the English Bible, *noon* or *noonday;* and as other two words have been formed from the root "tzohar" by the assumption of servile letters to it, the one signifying oil, as in Deuteronomy vii. 13, and the other to make oil, as in Job xxiv. 11, the lexicographers have therefore assumed, that the radical idea expressed by the word is, *to send out or admit clear light.*

It was, no doubt, with an impression of the accuracy of this assumption, that "tzohar" was translated window.

The employment of the plural form of the word, however, in the sense *noon* or *noonday*, leads naturally to the inference that this use of it is only figurative; and so the literal meaning of the singular noun may have been something different.

There is a condition of the text which goes to prove that window is not the proper meaning in the passage under consideration. Neither a window nor a door could, with propriety, be referred to as any thing added to a building. With regard to the door mentioned in the text, this circumstance is correctly attended to in the expressions referring to it,—"the door shalt thou set *in* the side,"—where *in* is the correct sense of the Hebrew. Had the word "tzohar" expressed a window or similar opening, no doubt a like form of expression would have been used regarding it; but we find a different one,—"a window shalt thou make *to* the ark,"—where *to* is the correct sense of the Hebrew.

In fact, the Hebrew tongue has another word for window (chalun), occurring in this very history of the flood (Genesis viii. 6), and of which the literal meaning is accurately fixed in other passages, by its connexion, as in Genesis xxvi. 8, Judges v. 28, and others *.

* There is another word translated *window* in this history of the flood

What has now been said, renders it more than probable that "tzohar" was not meant to express a window. It is our business, then, to look out for the true meaning.

Happily the Greek translation of the Septuagint throws an important light upon the question; and as the sense, in which it is obvious the translators understood the word, makes the whole passage under consideration highly intelligible, and in all respects consistent with itself, we can have no hesitation in admitting it as the right one.

The words which the English translators have rendered, "*a window shalt thou make to the ark*," the translators of the Septuagint have rendered "επισυναγων ποιησεις την κιβωτον," where επισυναγων can obviously bear no other meaning than "*bringing, or gathering together, upwards, or towards the top.*"

It is evident from this, that the Greek translators understood the word "tzohar" to imply the peculiar form of the ark itself, and not to express a window or opening; and their interpretation of it must have been "*a narrowing or contracting top*," finishing above in a narrow ridge, like the pavilioned roof of a cottage. With this sense, the sentence of the Hebrew completely accords with the following one, and both sentences make an intelligible and consistent whole,—and are, "*a narrowing top shalt thou make to the ark, and in a cubit shalt thou finish it above;*" to which the literal translation of the Greek is entirely equivalent,—"*gathering it together upwards shalt thou make the ark, and in a cubit shalt thou finish it above.*"

Having obtained this light on the subject, we can return to the Hebrew language, where we find, although not the word "tzohar," yet a word (tzor) containing its only two radical letters, used (when we view what it implies in respect to the form, and not the material) in a sense analogous to that which we now give to it; as in Exodus iv. 25, and Joshua v. 2, 3, where it means a sharp-edged or *wedge-formed* stone, or other instrument; and this, again, may furnish us with a key to the origin of the employment of the plural form of "tzohar" in the sense

Genesis vii. 11, and Genesis viii. 2; in the margin *floodgate*. The same word is found in many other passages; and in Hosea xiii. 3, the connexion determines its meaning to be, *chimney* or *vertical opening*. It is therefore used figuratively in Genesis.

noon or *noon-day*, expressing the arrival of the sun at the ridge of the heavens, as we now say that he culminates when at noon.

There is, indeed, if we confine our attention solely to the Hebrew text, a difficulty remaining in the position of the servile letter *he*, which, in the practice of the Hebrew tongue, is not interposed between the letters of a root to vary it, though often added to them. But surely this difficulty is not of sufficient importance to hinder our adoption of the consistent meaning of the word, to which the early Greek translators have directed us, when we reflect what advantages they possessed for learning the true meaning.

In fact, even independently of the result of this criticism, we should find it the most consistent, intelligible and simple explanation, to deduce the form of the ark, now indicated, from that sentence in the passage, in which there is no obscurity, "*in a cubit shalt thou finish it above;*" for the verbal affix, translated *it*, obviously refers to the ark itself, and not to 'tzohar;' and so sensible of this have the commentators been, that, while they have conceived the ark itself to be a parallelopiped, they have at the same time felt it necessary to suppose that there was a sloping covering superadded to it, to meet the condition expressed in this sentence.

The result of our inquiry is, that the ark of Noah was formed of a rectangular base, having sides springing up from its edges, and inclining inwards, till they met over its middle; the coverings at the ends inclining inwards and upwards likewise. A cross section of the ark would thus form an isosceles triangle, resting on its longest side, and the two equal sides forming each an angle of about fifty degrees with the base.

A vessel constructed in this form would be altogether unfit for carrying sail. But this was not the purpose of the ark. It was intended only for floating on the surface; and, bearing this in mind, let us enquire what advantages the form secured.

It was obviously possessed of great strength. In the triangular form, every beam, like those of an anchor roof, formed a brace, longitudinally directed to resist any tendency to change of form. The partitions dividing the rooms within, running not only across, but lengthwise also, as the large dimensions of the structure evidently admit and imply, and the internal horizontal floors, supporting both these again, furnished numerous braces to strengthen every part of the fabric.

But this was not the only advantage. Its outward form was that which is of all others the best adapted to elude the force of the waves in a stormy sea. The most ample experience has proved, that an inclined plane, such as it presented on all sides to the waves, renders their stroke harmless. We shall not refer for evidence to the dikes of Holland and Denmark, where a slight covering of straw ropes is found sufficient to protect their sloping surfaces from the effects of the heaviest seas, as it may be said the inclination of the planes there is much lower than in the figure we have described. But we may refer to the extremities of our own piers and breakwaters, which are found liable to little injury from the heaviest seas, when they are made to meet them in an inclined form; and also to the tapering bases, which our engineers have employed with so much success in our lighthouses, built, some of them, in the midst of the waters. Above all, we may refer to the judgment of a person who had perhaps more experience than any other individual, of the effects produced by the waves on ships at sea, and who remarked the efficacy of even a comparatively slight inclination of the sides to prevent injury. In the Letters of the late Lord Collingwood, we find it stated by him, that the old ships of his fleet, built, according to a former practice, with the upper decks narrower than the lower, and consequently having their sides inclined inwardly, suffered comparatively little, during their long cruizes under his command; while the new ones, built with vertical sides, an intended improvement, to give more room on the decks, were exposed to much injury from this form of structure, the waves beating upon them with greatly increased violence.

By the peculiar form of the ark now pointed out, its contents are necessarily reduced to a little less than one-half of what the parallelopiped affords. According to Dr Arbuthnot, the best authority on such questions, the burden, granting the form to have been a parallelopiped, amounted to about 81,000 tons. The triangular form will still leave a capacity of more than 35,000 tons, allowing Dr Arbuthnot's estimate of the cubit; forming yet a vessel so large, in comparison with any that we are accustomed to build, that we can easily conceive, as a detail of particulars would shew, it was sufficiently ample for the purpose for which it was intended. Into that detail we need not enter, as it is found fairly enough exhibited by several commentators on the passage.

It will be objected to our investigation, by some persons to whom, from respect to the very feeling whence the objection arises, we would not willingly give offence,—that, to enter into any proof that the structure of the ark was the best which we can conceive for fitting it to encounter the shocks and hazards to which it was exposed, is unnecessary, when we reflect, that He who warned Noah of the approaching catastrophe against which it was provided, and commanded it to be built, could also preserve it from every danger. This last position no reflecting mind will controvert. But the answer to the objection lies within narrow compass. He was pleased to employ human agency and ordinary means for the preservation of Noah and his family, and the living creatures that were saved with them; and if it be delightful to the contemplative mind to observe the numberless wise contrivances, the uses and ends displayed, the infinity of wisdom, in short, poured over the immensity of his creation, it is also highly gratifying to it to find an analogous proof of wisdom in its admirable adaptation to its end, in this structure, fabricated by his express directions.

So long as we depended on the use of masts and sails to effect the movements of our ships, we could not have attempted in their construction, any approach to that form which we have described. But now that, in the power of steam, we have the means of movement within the vessels themselves, it may not, perhaps, be hazarding too much to predict, that we shall speedily take a lesson, from the first vessel of which we have any account, for the improvement of the forms of our own. A previous desideratum is indeed necessary to be accomplished,—the placing the whole of the machinery below the surface of the water, to protect it from the hurtful stroke of the waves; and of obtaining this we have no reason to despair, having, before our eyes in nature, means displayed, analogous to those which may procure it for us. It would then be not difficult to shew, that the form of the ark, with the modifications necessary to fit it for making way through the water, would be the best and strongest form of a steam-ship. In this case we should be compelled to decline all aid from masts and sails, but the privation would be compensated, by the greater facility with which the ship would make its way against a head wind and sea; we should want, too, the advantage of a large open deck for those on board; but this would be compensated by their greater safety in the storm.

It having been deemed necessary by the author of the above inquiry, to investigate the stability of equilibrium of a floating body, of the form there assigned to the Ark, he finds the result quite satisfactory.

The rule, given by Laplace, for determining the stability of equilibrium of a floating body is, "That the equilibrium will be stable in every direction, when the sum of the products of each element of the section of the floating body, at the level of the fluid, into the square of its distance from that horizontal axis, through the centre of gravity of the section, in relation to which the sum of the products is a minimum,—is greater than the product of the volume of the displaced fluid, into the height of the centre of gravity of the floating body above the centre of gravity of the volume."

Supposing now a vessel of the form of the Ark to be immersed, by the weight of its materials and lading, to the depth of 6 cubits, which is rather more than one-third of its whole tonnage, and that the weight is so uniformly distributed, that the centre of gravity is the same as if the body were homogeneous, in that case the former sum would be to the latter in the proportion of 18 to 7 nearly.

Were the centre of gravity to continue the same, the ratio of the stability would decrease with a deeper lading, owing to the rapid decrease of the section of flotation. Were the body immersed to the depth of 9 cubits, which is very nearly one-half of its tonnage, the former sum would be to the latter only in the proportion of about 8 to 5, and were it immersed to the depth of 12 cubits, or somewhat less than two-thirds of its tonnage, the ratio of the former and latter sums would be only as 7 to 6.

But it is quite evident, that, in arranging the lading, the centre of gravity of the floating body may be brought below that of a homogeneous body, and that the facility of doing this increases with the depth of lading, insomuch that, in very deep ladings, the centre of gravity of the floating body may be very easily brought below that of the displaced fluid, in which case the stability would be absolute in every rate of lading.

A remark may be added in regard to another point; and that is, the means of obtaining ventilation. It would be difficult to conceive any form of vessel better fitted for securing this, in safety from the influx of the waves, above which the ridge of the ark would still be greatly elevated at very considerable depths of lading.

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*Remarks on Audubon's "Birds of America *," and "Ornithological Biography †."*

All objects of nature are capable of exciting intense interest in the mind of man, the moment he begins to look upon them as fragments of the vast and wondrous machinery of which he himself forms a part. It were difficult to say what collective portion of this magnificent system ought most to attract our attention, for all its parts are so mutually connected, that it is impossible to obtain any just conception of one, without extending our view to others.

Different minds are differently organized, or are differently biassed, one preferring this, another that, branch of study; and as no mind is capable of grasping the whole, the arrangement is obviously beneficial both to the individual and to the mass. Setting aside the silly and short-sighted spirit, that induces one to extol the department to which he has devoted himself, the man of truly philosophic mind views with pleasure the labours of all who endeavour to catch a glimpse of the order that has prevailed in the collocation and arrangement of the mundane objects, which, being the only realities from which the unaided efforts of man can derive knowledge fitted for enabling him to attain the abstractions alone suited to the gratification of his intellectual powers, are to him the only legitimate objects of study. Whether it be the resplendent gem, buried deep in the solid

* The Birds of America, from original drawings, by J. J. Audubon, F. R. S. E. and L., &c., folio.

† Ornithological Biography, or an Account of the Habits of the Birds of the United States, by J. J. Audubon, F. R. S. E. and L., &c. one vol. royal 8vo.

mass of the globe, or the flower glowing in the delicately pencilled hues of its summer splendour, or the animal instinct with life, and impelled to action by passions and emotions excited by the communication of external existences through the medium of his senses, that is to him the magnet of his versatile mind, it matters not. The universe is full of objects, the entire nature of any one of which no man has ever comprehended, and of which, no one is unworthy of the most intense regard of the brightest intellect, seeing it is the manifestation of an infinitely brighter. But of the numerous groups of objects that constitute the garniture of our planet, none is a more general favourite than the class of birds. The school-boy, when his irksome task is over, hies him to the greenwood to search for the curiously constructed nest in which the mellow-piped blackbird, or the gaudy finch, or the little cheerful wren, has deposited its cluster of painted eggs. The young savage views with delight the airy forms that flutter and flit on the forest boughs, and prepares his pop-gun and tiny arrows. Man immured in cities, seeks to bring around him the freshness of nature; and, while he decorates his habitation with the flowers of distant climes, forgets not to hang up a gilded prison for the little warbler of the woods, that it may delight his ear with its music, or his eye with the brilliancy of its varied plumage. Man roaming the wilds, decorates his person with the spoils of the aerial wanderers; and vain woman, gliding along in the gay saloon, loves the graceful waving of the costly plume, with which she seeks to add to her attractive powers. But enough:—every body knows that birds are universal favourites.

In every department of natural history, knowledge has made slow progress. For ages, men have been contented with a superficial idea of its objects. Unfortunately, as some might say, for its progress, it seems to most people so simple a science, that they imagine they have nothing more to do, in contributing to its advancement, than to see and describe. Hence, Ornithology has too often been in the hands of men ill qualified for the task which they had undertaken. One is fond of birds, as every body is, and fond of shooting them, as many persons are; and he fancies, that an account of the colours of their feathers, however vague, may benefit the world. So he prepares his book, and is forthwith immortalized. Another is fond of drawing, as well as of birds. He is fonder still of his own glory, and he resolves to perpetuate the results of his labours, by having them engraved. Then is the world gratified by the sight of birds, which, in form and attitude, resemble nothing in existence, but which are made known by the excellent expedient of engraving their names beside them; and this man also passes into immortality. Another, fond of the fireside, and of reading books, gathers around him the aggregated wisdom of ages; and studying the productions of the forests of the Wabash, or the ranges of the Himmaleh, as delineated, not in the book of nature, but in the books of men, perhaps little better qualified than himself, and who have described birds from skins and feathers, with a bill stuck at the one end, and two withered legs near the other, comes upon the astonished world in all the glory of authorship. Others are fond of marshalling birds into classes, orders, tribes, divisions, subdivisions, groups, genera, subgenera, &c., or of wheeling them into circles, or extending them in lines; or they may make them diverge from types, or set them a marching in pairs, or in fives;—and many other fooleries are played off for the benefit of science.

But every now and then does there appear a man, who sees things not as other men see them; and he, communing with Nature in the wilderness, or scrutinizing her productions in the silence of his closet, elicits the elements that are one day to accumulate into the stable basis of a system which shall form a temple, dedicated to the genius of the universe. Of one of these men there is somewhat here to be said.

John James Audubon, a native of Louisiana, has been from early youth addicted to the admiration of nature. In a beautiful country, teeming with animal and vegetable life, the profusion of which at first tended to render him undecided as to the particular path which he ought to pursue; he at length, struck by the beauty and variety of the feathered tribes, their manners and occupations, their wonderful migrations and their mysterious instincts, resolved to make them the principal object of his study. A pure passion gave energy to his mind. He studied nature, not with the view of immortalizing his name by his discoveries, nor even with a desire of infusing a portion of his spirit into his fellow men, much less with the hope of increasing his pecuniary stores, but simply from an instinctive impulse, an admiration of, a love for, the objects that manifested to him the attributes of their Divine Author. To perpetuate their remembrance, and render them ever present to his mind, he first tried to preserve their skins. But their faded tints, the stiffness which could not be avoided in restoring them to shape, and the consequent want of seeming animation, determined him to represent them by the pencil. Numberless drawings were made, but year after year they were consigned to the flames. At length, beginning to be somewhat pleased with his attempts to imitate nature, he commenced a collection of drawings, which, after more than twenty years of almost unremitted observation of the habits of birds, and after he had shot and examined specimens of all the forms that he could find in the vast regions of the United States, at length amounted to several hundreds. Still he had no other object in view than that of studying and depicting nature. Finally, after a visit to Philadelphia, which had opened his eyes to the ways of men, he began, in the solitude of the forest, to commune with himself as to the possibility of laying his labours before the world. "Happy days, and nights of pleasing dreams!" says he, "whom the wise men of the west had denounced as a wild woodsman, and whom, even his friend, the Prince of Musignano designates as a 'painter-naturalist.' "I read over the catalogue of my collection, and thought how it might be possible for an unconnected and unaided individual, like myself, to accomplish the grand scheme. I arranged my drawings, improved them as much as was in my power; and, as I daily retired farther from the haunts of men, determined to leave nothing undone, which my labour, my time, or my purse could accomplish." The 'grand scheme,' however, was destined to be accomplished,—at least it is in progress. Mr Audubon left America and came to England. His native country was either unable to appreciate his genius, or unable to aid his efforts, and England did both. The Americans may justly be proud of their achievements, and no people can be more disposed to boast of their good qualities; but, although they may boast of an Audubon, they must leave to England the merit of having fostered him.

"As I approached the coast of England," says he, "and for the first time beheld her fertile shores, the despondency of my spirits became very great. I knew not an individual in the country, and although I was the bearer of letters from American friends, and Statesmen of great eminence, my situation appeared precarious in the extreme. I imagined that every individual whom I was about to meet might be possessed of talents superior to those of any on our side the Atlantic! Indeed, as I for the first time walked on the streets of Liverpool, my heart nearly failed me, for not a glance of sympathy did I meet with in my wanderings for two days. To the woods I could not betake myself, for there were none near. But how soon did all around me assume a different aspect! How fresh is the recollection of the change! The very first letter which I tendered procured me a world of friends. My drawings were publicly exhibited, and publicly praised. Joy swelled my heart: the first difficulty was surmounted. Honours which, on application being made through my friends, Philadelphia had refused to grant, Liverpool freely accorded."

It is unnecessary to follow Mr Audubon in his progress through England. Suffice it to say, that, in Edinburgh, he commenced the publication of his "Birds of America." After a few plates had been presented to the world difficulties occurred. The engraver, Mr W. H. Lizars, expressed his satisfaction at being relieved of the work, which was transferred to Mr R. Havell jun., a London artist, who has continued the engravings. The work commenced in 1827, and already the first volume, consisting of 100 plates, is completed. It will be followed by at least three of equal size.

In estimating the merits of a book, it may in some few cases be necessary to employ the carpenter's rule. Without measuring with as much accuracy as Mr Audubon would employ in transferring to his paper the claw of a Humming bird, or the nasal plumelet of a Regulus, we find the pages of his work to be three feet three inches in length, and two feet two inches in breadth. This gigantic volume, in a battle of the books, would doubtless play its part to astonishment, and, by mere weight, overthrow a whole battalion of the multitudinous romances, novels, poems, and nondescript skirmishers, with which the land is overrun. But in modern warfare, thanks to gunpowder and wit, a stripling may level a giant, and a duodecimo may display better generalship than a double elephant folio. "*Incidit ingens ictus ad terram.*" The reason which our author assigns for these extended dimensions, is his desire of representing the objects which have occupied his pencil, of the size which Nature gave them.

As other authors have proffered a like excuse for the amplitude of their sheets, the delineations on which, nevertheless, hardly convey so accurate an idea of the originals as the diminutive wood-cuts of Bewick, let us see how Mr Audubon acquits himself. The first object presented to us is the Wild Turkey, and, in this instance, the paper is barely large enough. The female Turkey, the Bird of Washington, the White-tailed Eagle, and a few others, fill their respective plates. The most beautiful groups, biographical scenes, representations of maidenly coyness, maternal affection, lordly misrule, republican sociality, and, in one instance, conjugal strife, occupy others to the very edges. On the other hand, we sometimes find a single bird, not much bigger than a Tomtit, claiming to itself the whole space of a sheet. Between these extremes there are various means.

On inspecting the plates in succession, one cannot fail to be struck by the peculiarities which they present. The most unpractised eye must instantly discover something in the aspect and attitudes of the birds, which he has never seen in art, and to obtain which recourse must be had to nature. The cause of this is to be found in the circumstance of the author's having borrowed from living nature. Others draw not from birds but from dried skins. Their representations are as stiff and distorted as it has pleased the bird-stuffer to make the originals. Mr Audubon's method of representing birds is as follows. Finding in the woods, the prairies, or the fields, a bird which he is desirous of figuring, he follows it, steals upon it unperceived, as the Indian steals upon the white man in his encampment, observes its motions and attitudes, studies its peculiarities, and then shoots it. He restores it to its favourite or characteristic attitude, by a method which, some years ago, he exhibited to the Wernerian Natural History Society of Edinburgh, and while it yet retains unimpaired the rapidly evanescent hues of its eyes, bill, and feet, he transfers its semblance to his paper. The bill, the claws, the scales of the tarsi and toes, the feathers, and every other part of its exterior, are carefully measured, and the drawing becomes a fac-simile. Even this method, precise as it is beyond any other, will not necessarily lead to perfection. We know persons, who, although they are acquainted with it, blunder on as they have been wont to do, producing birds with three joints in their hind toes; legs, the origin of which is any where but in the right place; necks like a distaff enveloped in tow, and feathers formed of hogs' bristles. There must be an intimate knowledge of the habits and peculiarities, of the whole family history of the different species, together with a proper acquaintance, not merely with the rules, but with the resources, of art, before perfect representations of birds can be produced. As no mere naturalist can represent a bird, so can no mere painter; we have witnessed the attempts of both, and the results were wretched caricatures. He who would figure animals must be indeed a "painter-naturalist."

Let any man conversant with birds lay before him any number of these plates selected at random, and he will instantly and unhesitatingly pronounce them true representations of nature. The characteristics of the species are present, the forms and attitudes are copies, the occupations are disclosed, the imagination of a poet has presided over the arrangement. From these plates, there is more to be learned by the student than he may at first imagine. A few examples will suffice to make good the assertion. But before we select a few plates for particular examination, let us remember that we must look upon them as scenes from nature, not merely as representations of birds.

In criticising a work of this kind, every one has a way of his own. One, without any real knowledge of nature, but having gathered ideas from museums, and technical descriptions:—bill brown, iris hazel, back umber, rump red, foreneck cinereous, breast and belly dirty-white, feet horn-colour, &c.—points out to you the beauties and blemishes which he perceives. Another, totally unacquainted with birds or books, trusts to his eloquence, that is, his faculty of uttering nonsense with a good grace. Another, knowing enough, but dull as a Dutchman, applies, in his criticism, rules adapted for the mensuration of planes and solids, tells you that a bill is too long, a feather too short, or a pupil oval when it should be round.

Plate LXXVI. *Virginian Partridges surprised by a Hawk.*—The savage ferocity of the bird of prey, manifested in the glare of his eye, the bill half open in anticipation of carnage, and the outstretched talons with which he is about to seize his terrified prey, seemingly perplexed in his choice by the number of birds which have in their terror become heaped upon each other, is a subject repugnant perhaps in itself, but rendered intensely interesting by the skill with which it has been managed. Almost every possible attitude is exhibited in the group. Some of the partridges are flying off with palpitating hearts; others are endeavouring to evade the murderer's grasp by dashing sidelong along the ground; some are beaten down and hampered by the rest; one upset, and desperate, meets the foe with its powerless claws and open bill. Terror and dismay are depicted in every countenance. Never before did we imagine that the passions of birds could be expressed in a manner so intelligible.

Plate XI. *The Bird of Washington.*—Powerful, sedate, and in an imposing attitude, whether this bird bears any resemblance to him after whom it is named or not, it is one of the most magnificent of the feathered race. As the colours are simple, and the parts large, one might imagine it no difficult task to represent an eagle; yet we have never seen one represented before.

Plate XVI. *Peregrine Falcons devouring their prey.*—A picture like this can hardly be called pleasing, yet this is one which has justly attracted the notice, and elicited the praises, of all who have seen Mr Audubon's splendid collection of drawings. The attitudes are highly characteristic. The general position of the female falcon, and especially that of its left leg, are finely managed, as is the foreshortening of the head and neck of the male.

Plate XVII. *Carolina Turtles.*—This is one of the most pleasing pictures in the work. In a cluster of Stuartia Malacodendron a dove has made her nest. Seated on her eggs, she is receiving from her ever kind and attentive mate, the food which he has been collecting for her. On a twig above is a love-scene in its commencement. The female, coy and timorous, has, in her sidelong retreat from the male, reached the extremity of the branch, and has already half opened her wings and tail to fly to another perch, whither her ardent admirer will doubtless follow her. The beautiful white flowers, and delicately tinted leaves, overshadow the pair whose nuptials have already been celebrated. One almost fancies he hears the cooing which has come softly, in the solitude of the forest, on the ear of the painter, and inspired him with gentle and pleasing thoughts.

Plate VII. *Purple Grakles.*—Maize-thieves, as they are not inaptly called. Two of these birds are perched on a stalk of Indian corn; they have attacked an unripe ear, torn off the husk, and devoured a large portion of the seeds. The male is calling to his fellows to join him. The female, already satiated, is flying off with a supply to her young. The attitudes are graceful and easy. The birds are evidently enjoying all the vigour resulting from abundant food and agreeable occupations. From this group we learn, in the first place, all that two stuffed skins could disclose to us, namely, that the beak, the feet, the head, the wings, and the tail, have certain peculiarities of form; and, secondly, that in summer the bird feeds upon the maize, and conveys the green and juicy seeds to its young. In habit and attitude, we see that the Purple Grakle approaches the crows, as well as the genus Icterus. We have, moreover, a representation of the maize, of which so much has lately been heard under the name of Cobbet's corn. The grouping is beautiful, the colouring accurate, and the engraving excellent. A more perfect and characteristic representation could not be made.

Plate XXI. *Mocking-Birds.*—The famed songstress of the American woods has formed her nest in a bush overgrown with the Virginian jessamine. A rattlesnake has made his way to it. Twisted around the stem, his tail raised in the air, the horrible reptile is stretching forward his distended jaws, hissing at the female bird, which, in her agony, almost suffers herself to become a prey to the monster. The male, full of courage, has crept upon the foe, and is aiming a blow at his eye. A pair of neighbours, attracted by the cries of the mocking-birds, are eyeing the snake from the tops of the twigs, and meditating a descent. The engraving of this plate is not in the best style, the female mocking-bird in particular, perhaps the finest figure which has come from the pencil of Audubon, is greatly injured by the coarseness of the engraving.

Plate II. The grace and elegance of the Yellow-billed Cuckoos gliding amongst the foliage of the papaw-tree in pursuit of insects, are unrivalled, although the execution of this plate is inferior to that of some others.

Plate LXXXIII. The House-wren is not very nice in selecting a place for its nest. A pair of these birds have nestled in an old hat stuck upon a twig. The male, perched on the edge of the hat, is commencing a little ditty, while the female, just arrived with a large spider, is delivering it to one of the young, which are eagerly squeezing themselves through a hole in the crown.

Plate LXXXVII. *Florida Jays.*—These beautiful birds, although they have no tale to tell, form a splendid picture. They are perched on the branches of the persimon, loaded with clusters of fruit.

In short, the general character of the work may be expressed as follows:—The birds are represented such as nature created them, of their full dimensions, glowing in all the beauty of their unsullied plumage, and presenting the forms, attitudes and motions peculiar to the species. In no case do they appear before us in the stiff and formal attitudes in which we find them in other works, perched upon an unmeaning stump or stone. On the contrary, they are seen in all imaginable positions, pursuing their usual avocations. The foreshortenings and varieties of attitude which induce painters generally to present side views only, seem to have been accounted as nothing out of the ordinary course of drawing; with so much delicacy, grace and vigour, have the most difficult positions been managed. A peculiar charm is given to these representations, by the circumstance that the trees, plants, and flowers of the districts in which they occur, are all represented, generally with surprising accuracy, and always with great taste. The flowing festoons of climbing shrubs and creepers, hung with broad leaves, garlands of flowers, and clustered berries, the lichen-crusted branches of the forest trees, and the decayed stumps on which the woodpeckers seek their food, are in themselves objects of admiration.

It is not enough to say that our author has invented a new style in the representation of natural objects; for so true are his pictures, that he who has once seen and examined them, can never again look with pleasure on the finest productions of other artists. To paint like Audubon, will henceforth mean to represent Nature as she is.

Nevertheless, there are faults in the work, as doubtless there must ever be in the most successful imitations of nature. A very few of the figures, if not positively bad, are poor, and must have been taken from drawings made long before the artist acquired the taste, or at least the facility which he now possesses. The Black-and-white Creeper may be instanced, although the plant on which it hangs redeems the character of the artist. In some cases, where the species is small, we might naturally expect a whole group, and are disappointed in finding only a single individual, generally a male. When only a solitary specimen of a rare or a new species had ever occurred to the author, this might well be pardoned; but even then, the individual might be represented in at least two different positions, so as to disclose all its parts. To be truly useful to the naturalist, the representations of species ought to include the male, the female, the young, and in some cases the bird in different stages. In the subsequent volumes we may expect to find the deficiencies supplied; and in the mean time may enjoy the pleasure which the contemplation of the wonders of nature and art, combined in this splendid work, cannot fail to awaken in the mind of any one alive to either.

It now only remains to say a few words of the engraving. Some of the plates at the commencement are by Lizars, the rest by Havell, the former *line,* the latter *line and aquatint* combined. Some of the first plates are rather coarse, but a progressive improvement is perceptible. Many of those towards the end, and indeed throughout, are extremely beautiful. Nothing more perfect than the last twenty engravings, for example, could be desired. Mr Havell has evidently mastered his subject, and is worthy of being associated with the great American naturalist in the production of a work which, as Cuvier has justly said, is the most splendid monument that has yet been raised to ornithology.

Accompanying the first volume of the "Birds of America," appears another of smaller dimensions, but still somewhat "on the grand scale," to which is given the title of "Ornithological Biography, or an Account of the habits of the Birds of the United States of America." It contains, as its title-page informs us, "descriptions of the objects represented in the work entitled The Birds of America, interspersed with delineations of American Scenery and Manners."

For our past and present state of knowledge, we have enough of systems. It were better that they who would enlighten us on the subject of nature's productions, should examine them in the woods than in the closet. Great as is the light that has been thrown upon the anatomical structure of birds, and many as have been the enthusiasts, who in forest and marsh have collected objects for description, little, very little, do we know of the habits and manners of birds, their pursuits, their migrations, and their diversified relations. A single work, written by a Scottish emigrant, presents us with the history, beautifully and accurately told, of many of the birds of a very interesting portion of the globe; but few have followed in the footsteps of WILSON*, and it would appear few are qualified either to observe or to describe as he has done, the objects of which men now begin generally to profess admiration, the living productions of nature. He who has read the beautiful biographies of Wilson, will hardly find pleasure in the unanimated details of most other ornithologists. All the ends of the earth have been searched for *new* birds, as we call those which have never yet been presented to the eye of civilized man, and daily are prepared skins pouring in from the most remote islands of the ocean and the central deserts of the continents; but the time will be when pilgrimages will be undertaken for the purpose of bringing home, not the knowledge of the existence, but that of the peculiar habits and actions of birds.

Observing nature with the eye of an enthusiastic admirer, Mr Audubon has traversed the dark forests of America, following the track of the discomfited and disconsolate Indian, has penetrated her cane-brakes and cypress-swamps, teeming with the loathsome and dangerous forms of reptile life, visited her ocean-lakes, wandered by the verdant margins of her magnifi-

* An edition of Wilson's delightful work, including also that of Charles Bonaparte, on the Birds of America, in four volumes, is at present printing in Edinburgh, under the superintendence of Professor Jameson,

cent rivers, and paddled his solitary canoe over the floods that have spread consternation and terror among the inhabitants of the alluvial plains of her midland regions. This, then, is the man, and not he who, seated in comfort by his table, fancies how things should be, from whom might be expected the completion of the descriptions of others who have pursued the same method. "It is greatly to be wished," says Charles Lucien Bonaparte, speaking of our author, in his Continuation of Wilson's Ornithology, the production of a learned, most accurate, and enthusiastic naturalist, "that whilst his work is preparing, a scientific abstract of his discoveries should be drawn up without delay." Here, then, is not indeed "a scientific abstract," but a detailed account of Mr Audubon's discoveries and observations.

As, in painting, our author has a style of his own, so also in writing. His biographies do not consist of the observations of others, eked out and distorted, so as to seem original. He professes to write only of what he has seen. Nor are they always conducted with that strict regard to method which characterizes the writings of the naturalists of the Linnæan school. Thus, in his description of the Wood Thrush (*Turdus mustelinus*), he commences neither with bill nor claw, but with the following beautiful apostrophe.

"Kind reader, you now see before you my greatest favourite of the feathered tribes. To it I owe much. How often has it revived my drooping spirits, when I have listened to its wild notes in the forest, after passing a restless night in my slender shed, so feebly secured against the violence of the storm, as to shew me the futility of my best efforts to rekindle my little fire, whose uncertain and vacillating light had gradually died away under the destructive weight of the dense torrents of rain that seemed to involve the heavens and the earth in one mass of fearful murkiness, save when the red streaks of the flashing thunderbolt burst on the dazzled eye, and, glancing along the huge trunk of the stateliest and noblest tree in my immediate neighbourhood, were instantly followed by an uproar of crackling, crashing, and deafening sounds, rolling their volumes in tumultuous eddies far and near, as if to silence the very breathings of the unformed thought! How often, after such a night, when far from my dear home, and deprived of the presence of those nearest to my heart, wearied, hungry, drenched, and so lonely and desolate, as almost to question myself why I was thus situated, when I have seen the fruit of my labours on the eve of being destroyed, as the water, collected into a stream, rushed through my little camp, and forced me to stand erect, shivering in a cold fit like that of a severe ague, when I have been obliged to wait, with the patience of a martyr, for the return of day, trying in vain to destroy the tormenting moschettoes, silently counting over the years of my youth, doubting, perhaps, if ever again I should return to my home and embrace my family;—how often, as the first glimpses of morning gleamed doubtfully amongst the dusky masses of the forest trees, has there come upon my ear, thrilling along the sensitive chords which connect that organ with the heart, the delightful music of this harbinger of day! And how fervently, on such occasions, have I blessed the Being who formed the Wood Thrush, and placed it in those solitary forests, as if to console me amidst my privations; to cheer my depressed mind; and to make me feel, as I did, that never ought man to despair, whatever may be his situation, as he never can be assured that aid and deliverance are not at hand."

The biographies of the birds are simple, as they ought to be, animated and interesting. The peculiar mode of flight is always given in detail; and the information which our author affords on this subject, which has as yet received little investigation, is entirely new. The pursuits of the birds, their food, their migrations, their nidification, and the other details of their history, are described. Then follows a technical description, including the form of the bill, the head, the feet, and other parts; the texture and form of the feathers; the colours of the various parts, and, lastly, the dimensions. The numerous accessory objects represented in the plates are also briefly described.

To relieve, as Mr Audubon says, the tedium of those who may have imposed upon themselves the task of following an author through the mazes of descriptive ornithology, he has interspersed descriptions of American scenery and manners. Gloomy forests, tangled cane-brakes, dismal swamps, immense prairies, majestic rivers, floods, tornadoes, and earthquakes; the migrations of the white men, the retreat of the red; the character and pursuits of the back wood's-men; the extensive inland navigations, and other subjects, form the materials of these instructive and amusing sketches. Surely, if ornithology so treated does not excite as much interest as a novel or a romance, it must be owing to the utter perversity of the human race.

The greatest objection to a work like the "Birds of America" is, that, on account of its great price, it can be seen and examined by few students of nature. But surely nature deserves a monument like this, which will remain a model for the imitation of her admirers. To complete the work for which he has been destined, its author intimates his intention of laying before the world a systematic and methodical account of all the birds of the United States. The observations of a whole life of unremitted labour ought not to be lost to the world; and their essence will form a worthy companion to the Manual of the Ornithology of Europe by the celebrated Temminck. The study of the habits of birds is as likely to throw light on their natural affinities as is that of their forms and structure; and with a knowledge of both, our author will confer the greatest benefit on science by promulgating his ideas on classification.

In the descriptive work which he has already published, there is contained a mass of facts which must be highly useful to the ornithologist, as being the result of personal observation under circumstances singularly favourable. It, moreover, contains sixteen species not before described. Perhaps a little more method in the arrangement of the details, in the subsequent volumes, might render them more easily consulted.

Interesting as the birds of America, or of any other portion of the globe, must prove to the ornithologist of all countries, when treated in the manner exhibited by the splendid works which have furnished the subject of the above remarks; still more so to the British ornithologist would be those of his own country. It is true we have already a large, if not a splendid work, from the pencil of Mr Selby; but, against that work might be urged the objection that has been made to Mr Audubon's, namely, its great price, while, at the same time, it is by no means such as to approach in any striking degree to the perfection which might be desired. Much, therefore, is it to be wished that Mr Audubon should undertake the delineation of the birds of Great Britain, which, with his matchless talents, aided by those of Mr Havell, would eclipse, not only all other representations of these birds, but even the "Birds of America," unrivalled as that work now is. Sure, the "Imperial Isle," the "Empress of the nations," ought to possess a work of this kind suited to her rank in the political and moral systems of our beautiful and mysterious world.

ORNITHOPHILUS.

Observations on the Glaciers of the Alps *. By F. J. Hugi, Professor at Soleure.

A JOURNEY devoted exclusively to geography or meteorology, executed by a man well versed in physical and natural science, affords a rich store of important observations, which aids powerfully in unveiling the secrets of nature. The narratives of De Saussure and Humboldt prove what advantage a superior mind may obtain from inspecting these particular regions. The Alps, although situated in the centre of the most civilized continent, have remained a long time without being studied; it is well known what science owes to the particular attention with which these mountains were studied by one of these learned men whom we have mentioned. Other naturalists have trodden in his footsteps, and notwithstanding, there are yet many points on which new observations are useful and often necessary.

Situated in a temperate climate, the Alps, by their elevation above the level of the sea, afford a multitude of phenomena which belong to polar regions, and which, notwithstanding, exhibit the peculiar characters which their elevation impresses. Mr Hugi, already known by many valuable works relating to physics and natural history, having, in 1828 and 1829, made excursions among the Bernese Alps, has collected the observations

* Translated by the Rev. William Ettershank, M. A.

which he had made on that interesting country, in a memoir which at first had been read to the Society of Natural History of Soleure, of which Mr Hugi is President, and which had afterwards been printed. The excursions of the author have been principally in the eastern part of the chain which separates the Canton of Berne from the Vallais, and farther from the Grisons. They reach to the summit of the Finsteraarhorn, the most elevated peak of the chain, and which does not yield to any among the Alps except Mont Blanc and Mont Rosa. The narrative of this attempt and some others analogous, will furnish matter for an interesting article in another number of this Journal; but we shall confine ourselves for the present to record some observations on the glaciers. The subject has been treated by Saussure in the first volume * of his Travels among the Alps, with the perspicuity and correctness which always distinguish this celebrated geologist; but new documents will not be useless. The attention of De Saussure, at the period when he published this part of his work, had been particularly directed to the chain of Mont Blanc, and consequently to the Glaciers of Savoy. The observations of Mr Hugi have been made concerning a different region, perhaps still richer in glaciers. It is interesting to compare the latter with the former.

The author established at first, as had been done by De Saussure, a distinction between two kinds of glaciers, for which the German language possesses two different expressions (*firn* and *gletscher*), and which, in French, are confounded under the denomination of glaciers†. The former is that stratum of granular and permanent snow, which covers the summits and the declivities of very high mountains; the latter is that of those large rivers of ice, more or less opaque, which descend from those mountains by lateral valleys, and often over an extent of many leagues, even to the heart of the inhabited valleys; they are also sometimes named *mers de glace.* Among the latter, the most remarkable are those which surround Mont Blanc, Mont Cervin, and Finsteraarhorn. All the others, from Savoy

* Edition in 4 vols. quarto, Neuchatel.

† Having had frequent opportunities of examining the glaciers of the Bernese Alps, we can vouch for the accuracy of Prof. Hugi's statements. —*Trans.*

to the Tyrol, are of less extent; the greater number belong rather to the first kind, that is to say, present frozen summits; which a little lower become true glaciers of the second kind.

Mr Hugi has particularly studied the vast sea of ice comprised between Grendelwold, the Vallais, Hasli, and the valley of Lotch, a desert region, above which there arise five or six colosses, of which the elevation exceeds 12,000 feet, and from whence issue, in all directions, a great number of glaciers. The whole of the glaciers, of the different kinds of groups on this region, afford an extent that may be estimated at 4½ leagues from south to north, and at 8½ from east to west, which gives a surface of about 38 square leagues.

"In general," says the author, "they assign too great a thickness to the mass of glaciers. It is between 30 and 80 feet at its extremity. Having met in the inferior glacier of the Aar, about a league above its extremity, a crevice which reached to the soil, I sounded it, and found a depth of 120 feet. There is on the great glacier of Aletch, at two leagues above its extremity, a little lake (Moriler See), often empty, of which the border affords a vertical cut of the glacier, which is not more than 100 feet; two leagues still higher, the glacier rises on the rocks between the peak of Aletch and the Faulhorn, and at this place it cannot be estimated at more than 150 feet. A deep crevice in the glacier of Viesch behind the Finsteraarhorn, does not indicate a greater thickness of ice. Often the glaciers of both kinds glide over the rock, and break vertically, and their anterior part is precipitated into an abyss; in these cases, the cut formed never exceeds 100 feet. During 20 years the inferior glacier of the Aar has advanced about one-fourth of a league. The shepherds who frequent its environs, and who know the depth of the valley which it has filled, affirm that the glacier cannot be more in this place than 80 feet thick.

"On the high peaks the frozen mass diminishes even to the thickness of only some feet. The peak of the Finsteraarhorn was completely bare in 1829; even its bases were seen in some places. The covering is equally thin on the Schreckhorn, the Jungfrau, the Titlis, and the greater part of the summits of the Alps."

"If, moreover, we consider the connexion that exists between the mountains and the glaciers which cover them; if, in particular, we consider the disappearance under the ice of certain formations or strata of rocks, and their reappearance in other places; if we attend to the course of the acclivity of the valleys from the extremity of a glacier to its commencement, &c.; we obtain the following conclusions:—The mean thickness of the glaciers of the second kind, which descend into the inferior valleys, is from 80 to 100 feet;* the thickness of those glaciers which are more elevated, and which fill the deeper valleys, may be considered as ranging from 100 to 180 feet. The glaciers of the first kind, which cover the summits, or extend over the declivities, scarcely attain 40 feet in thickness. Doubtless, there are deep holes in the rocks, where the thickness of the ice is much more considerable; the thickness likewise diminishes at the limits of its extent. Besides, it is often formed after avalanches in extraordinary heaps in certain places. In like manner, a winter very abundant in snow may augment, for a short time, the thickness of the covering of the peaks."

"The ice of a glacier of the *second kind*, is almost as hard as rocks; the sun, the rain, and the warm winds, slightly melt its surface, but never soften the mass. If we travel on one of these glaciers, even to more elevated regions, we see it, at a height of about 7600 feet above the level of the sea, pass rapidly into the condition of ice of the first kind. It is composed of round grains, about the size of a pea; the sun softens it to such a degree, that we often sink in it to the knees; but a moderate cold restores it to its former hardness. The line of separation of the glaciers of the two kinds, is no other than the limit of perpetual snow, that is to say, the height above which snow does not melt in summer. It is customary to place this limit in our mountains between 6000 and 9000 feet; but if we consider more accurately the melting of the snow, we shall be obliged to assign to this limit a much greater range. It does not appear that they have sufficiently distinguished, in this determination, each of the two kinds of glaciers, and the snow properly so called; they have not observed correctly the different manner

* De Saussure obtained precisely the same result at the glacier of Bois, but he thinks that accidentally he met with much thicker ice. Vol. i. p. 440 and 523.

in which these different masses are associated; they have been contented with viewing them from the bottom of the valleys. The inferior limit of glaciers of the second kind descends even to 3200 feet above the level of the sea, and varies according to the situation of the glacier, its declivity, the rocks which surround it, the depth, and the steepness of the ravine which encloses it, to a height of 7400 feet, that is to say, to the lower limit of glaciers of the first kind. The limit of the snow, specially considered as to its melting, is still much more uncertain. While, on the southern declivities, it rises even to 10,000 feet; it descends on the northern extremities even to the lower limit of glaciers of the second kind; it varies considerably in the same place, according to seasons, the insulated nature of the peaks, the connection of the declivities, their respective position and inclination, the nature and stratification of the rocks, the accumulations of debris, the interior heat of the earth, the vegetation, and, above all, the prevailing direction, the force, and the temperature of the winds; all these cirumstances exert such an influence upon the height of this line, that it is impossible to determine it precisely. There, where avalanches and violent tempests have not formed extraordinary accumulations, it may happen in the month of August, that, at a height of 12,000 feet, there is not a trace of snow to be found."

Concerning the lower limit of the glaciers of the *first kind*, the alpine excursions made by Mr Hugi during many years have shown that it not only does not vary in the same place, but that it varies little from one place to another, and that it is but little affected by the situation of the declivities and other circumstances which have been mentioned. Observations made in different parts of the Bernese chain, show that it is towards 7600 feet of elevation, where the permanent glaciers of the first kind commence, and that at 7700, we find ourselves wholly in the region of these glaciers. Among the Pennine Alps, this limit appears to be a little more elevated, as we find it at 7800 feet on the Gries, and the ridge of the valley of Binnen, mountains situated at the eastern extremity of the chain of the Valais.

The intimate constitution of the ice, in the glaciers of the two kinds, offers materials for numerous observations. The following are those which have been collected, when, going from the inferior extremity of a glacier of the second kind, we rise gradually to those of the first kind, even to the highest peaks.

"Often," says Mr Hugi, "blocks of ice detach themselves from the extremity, or even from more elevated parts of a glacier of the second, and rest upon the soil. These blocks, exposed to the rays of the sun, and at an elevated temperature, do not melt, as is the case with ice in general; but if they are not of very large dimensions, they first break into many pieces. I have often examined these detached blocks, particularly on the glacier of Aletch, in the Lake of Morile, which has been already mentioned.

"This little lake being completely empty, the glacier which formed one of its sides broke through all its thickness, and filled the bottom of the lake with its debris; some of the blocks had a diameter of 40 feet, but the greater number were from 4 to 12 feet. An examination of these fragments is particularly necessary to enable us to know the constitution of the ice, and the stratification of the glacier.

"The mass is formed of crystals imbedded in each other, in such a manner as to be moveable not only in the broken blocks of which we speak, but upon the borders of the glaciers themselves; above all, where protuberances and ridges are found. Notwithstanding this mobility, these crystals do not separate from each other; a certain force is even necessary to detach one of them from the mass, and they are seldom detached without breaking. These crystals, of which the larger have a diameter of two inches, and the smaller of one inch, are articulated into each other in all positions and directions, and each of them aids to enclose its neighbour in the mass. But if only one of them be detached, it is easy to detach all the rest successively with the fingers, and thus destroy a whole block. A mass is often decomposed of itself into a heap of crystals, when some of its crystals are separated. It is scarcely possible to assign to these crystals a determinate form. They are rather oblong than cubical; and they have very often from one side, and rarely from two, a strong jutting out of articulation, with surfaces and angles imperfectly defined. Their surface is rough and furrowed. I have never been able to discover at the interior a regular crystalline contexture. It is to be remarked, that it is only in detached blocks, or on water sheds, and never in the interior of a compact glacier, that the crystals separate of themselves and fall into a heap."

"I have had an opportunity of examining the inferior surface of many glaciers of the second kind, such as those of Uraz, of Viesch, of Munster, the superior glaciers of the Aar, and of Grindelwald. This surface is continually melting; it exhibits sorts of domes or vaults, and the glacier rests on the rock only by some insulated feet. The ice is very smooth; traces of the joints of crystals marking it like network on the exterior; the ice is melted more deeply on these traces than elsewhere. As to the superior surface, it is, on the contrary, very rough, the fusion is, in this case, deeper at the junction of the crystals, so that they form many protuberances. The ice at the interior and exterior, where there is a low temperature, or after a very cold night, exhibits but in an imperfect manner the forms of crystals which we are describing; and its aspect again approaches that of compact ice. But if some coloured acids be poured on it, or alcohol, there appears instantly a cellular tissue delineated on its surface, which makes the outline of each crystal appear. If a salt be employed, the mass commences to decrepitate, and the form of the crystals is better defined.

The ice of the glaciers of the second kind contains, like ordinary ice, a great number of vesicles. When those vesicles are terminated in a sharp point, I have found, in melting the ice under water, that they do not contain air; whilst, if they are rounded, which rarely happens when they are opened with a needle, or melted under water, they disengage air. The ice of a glacier of the first kind is much richer in gaseous matters, which are probably nothing else than atmospheric air, which appears to be, in this case, the agent of transformation; the air and the ice have a reciprocal action, from which it results, that the ice, after having decomposed and solidified the air, passes itself into that state wherein it constitutes glaciers of the second kind. The sharp-pointed vesicles have always the apex turned downwards. It is possible that they contain air much rarefied, which disappears when it is liberated under water. We have not hitherto made exact and decisive experiments on this subject.

The crystals, or rather the grains of the glaciers of the second kind, attain their greatest dimensions at the extremity of these glaciers. The more the glaciers are prolonged and extended into the inferior valleys, the grains are the larger. Thus, those of the glacier of Aletsch are greater than those of the glacier of Rosenlaui; at the base of the former, the crystals have a diameter of more than two inches. Two leagues higher, near the Lake Morile, they are only the size of a walnut; in ascending two leagues farther, at the foot of Faulhorn, they are much less still; and, finally, the glacier passes to the state of the first kind.

At the bottom of glaciers, the grain is almost of the same size at the superior and inferior surfaces, and in the interior of the mass; but if they approach the superior limit, or, still better, if they ascend on a glacier of the first kind, even to the highest peaks, they find that the grain increases in dimensions, from the superior surface even to the bottom. Thus a little above the inferior limit of a glacier of the first kind, at the depth of some feet, they find the ice in the condition of the second kind; at a height of 2000 feet this change only shows itself in the lowest. These important facts will serve farther to confirm the opinion, that every glacier of the second kind commences in the upper regions, under the form of the first; that this transformation commences at the surface, and that afterwards, in the lapse of years, the mass descends into the valley, and, at the same time, approaches the soil by the mere act of the melting of the inferior surface. With time, each grain augments in magnitude; and so explains, to a certain degree, this progression of the glaciers, which is an incontestible fact.

The shooting of crystals into each other does not unite all the mass of the glacier from the superior to the inferior surface. The blocks of ice which we have observed, in the same time that they are decomposed in their crystalline elements, also separate very regularly into strata, which, as long as the cold does not unite them, do not show any trace of that connexion which exists in the mass of each stratum. I have seen, in the Lake of

Morile, blocks of ice more than twenty feet high, placed so that their strata were vertical. When the exterior stratum began to be decomposed by the action of the solar rays, I easily detached a whole stratum by means of a hammer, or with my mountain-poll: it shook like a wall and fell into pieces; I was in danger of being crushed by the unexpected fall of this mass. Afterwards, in proportion as each of the consecutive strata began to be decomposed, at the same time it began to bend, and soon afterwards it fell. At the extremity of some glaciers, the dust and earthy matters form blackish lines, which trace the limits of the strata. When this is not the case, the arrangement, which is most frequently horizontal, is easily discovered by means of the hammer. The superior strata are generally from half a foot to a foot in thickness; this thickness increases with the depth, so that in the great glaciers, the thickness of the lower strata may amount to about eight feet. The only glaciers which form an exception, are those which are broken on the rocks, and are formed again lower down; these are subject to no rule. In the small glaciers, which extend less towards the base, the inferior strata differ less from the superior. These facts agree with the increase of the crystals, and with the gradual extension of the glaciers. In general, the strata are parallel to the superior surface of the glacier; they only deviate from it in rare cases, where the inferior vaults have fallen, and where the melting at the bottom has taken place in an unequal manner."

"The colour of the small detached fragments of a glacier, or of an isolated crystal, is decidedly white and clear; we never perceive any trace of other colours. But if we examine a greater mass, as the thickness increases, it becomes of a blue colour gradually more deep; it is at first a sky-blue scarcely discernible, then a fine enamel-blue, and, finally, a very deep azure-blue. In certain glaciers, there is associated with the azure-blue a small tint of sea-green, which sometimes predominates. In some places, and especially in the fissures and crevices formed beneath by melting, the gradation of colours which we are pointing out is so pure and clear, that we admire it, without being able either to describe or imitate it. Thus we discover what is of importance, the mass of the glaciers corresponds to the atmosphere in an analogous manner. It is only the whole mass of the atmosphere which presents this beautiful colour, to which we have assigned the characteristic name of sky-blue, and to which different circumstances give a different tint, the enamel-blue, the azure and the sea-green. It is remarked that certain glaciers exhibit certain particular tints, analogous to those which the atmosphere presents in its different modifications. The same parallel which we have shewn between the atmospheric fluid and water in a solid state, may be farther established with water in a liquid state. Proportionally as we ascend, passing from a glacier of the second kind to that of the first, these varied tints disappear, and this latter assumes a dull white, which has sometimes a feeble bluish tint. This comparison of the two kinds of glaciers, under the relation of tints, is not without use; it demonstrates to us that the colour increases from intenseness, when we pass from a glacier of the first kind, where the substance is strongly mixed with atmospheric air, to that of the second kind, where it is more homogeneous. It is, then, to the presence of air in the ice that we may attribute these modifications; and it is not difficult to understand how the ice, which contains much air, does not exhibit that transparency, that clearness, and that azure tint, which are peculiar to that of the second kind, of which the formation is more regular, and where the globules of air are either expelled or decomposed."

(*To be continued.*)

New Observations on the Blood-like Phenomena observed in Egypt, Arabia, and Siberia; with a View and Critique of the Early Accounts of similar Appearances. By Mr C. G. Ehrenberg. (Concluded from page 136.)

These memoirs on red snow induced Nees Von Esenbeck to publish an interesting essay on the same subject. Scoresby, in a communication to Professor Jameson, in the Edinburgh Philosophical Journal, informs us that he observed orange-coloured snow in Greenland, which he considers as a different species from that described by Captains Ross and Parry. He attributes the colour to minute marine animals. In the year 1824, a report was general throughout the province of Padua, that blood-red spots were observed on all kinds of food. Mr Sette ascertained that this appearance was owing to a small red-coloured mushroom, belonging to the genus Mycoderma of Persoon. De Candolle, in 1825, observed the surface of the Murten Lake in southern Switzerland of a red colour. This beautiful appearance he ascertained to be caused by a minute plant, a species of *Oscillatoria*, which he named from its colour *rubescens*. It was chemically examined, and found to contain, 1. A red resinous matter; 2. A green resinous matter; 3. A large proportion of jelly; and, 4. some earthy salts and oxide of iron. The chemists concluded that the colouring matter of the Murten Lake was an organic animal matter; and as it was an oscillatoria, they concluded that the oscillatoriæ were to be considered as belonging to the animal kingdom.

Here we have only to reflect that the larger mushrooms, and even more highly organized plants themselves, contain what is called animal matter in their composition; that Alexander Von Humboldt long before, by means of nitric acid, changed them into a fatty substance; and that many aquatic plants as well as animals produce calcareous deposits, a fact circumstantially related by Schweigger, in his observations on natural history made during his travels. It does not, therefore, seem consonant with experience, unconditionally to determine the nature of any body by its chemical quality; and how far the infusion may have been blended with the oscillatoriæ during the chemical process, may, moreover, have escaped observation.

Further, I have in another place proved that the simpler animals are distinguished from plants by more determinate characters than the chemical composition.

In addition to this, it is remarked that the appearance of sunshine causes the oscillatoriæ to rise to the surface of the water, and its disappearance causes them to return and sink to the bottom.—*Mem. de la Soc. Phys. et d' Hist. Nat. Geneve*, iii. p. 30. The cause of the latter appearance may, indeed, be a disengagement of gas.

Bory de St Vincent, in Dict. Class., calls these oscillatoriæ *Osc. Pharaonis*; but the reason for suppressing the old name, because there is another red kind of the same species which has a different name, is just as untenable as the reason for assigning the new name, which is grounded on the erroneous hypothesis that the Egyptian appearance is the same with that referred to.

An extensive series of laborious observations on the chemical ingredients of meteoric masses, by Professor Zimmerman of Giessen, are connected with our present subject. These were occasioned by the occurrence of a red shower that fell in Giessen, 3d May 1821. Its water was of a peach-red colour, and flakes of a hyacinth colour floated on its surface. It was only chemically analyzed, but had it been botanically and microscopically examined, which it was not, it might easily have afforded an interesting and satisfactory result. The collective result of this investigation was, as is well known, that there is in meteoric water a peculiar animal and vegetable substance, chemically different, from the extractive matter and the gluten of plants and animals, and this substance, on account of its uniform yellowish-brown colour, is called *pyrhine,* that is, yellow matter. Among the different volatile substances formed near the surface of the earth, this may be taken up by the clouds in an aëriform state, and again precipitated in rain water, as a stimulant and nutritive material for plants and the lower animals. It may form the first thin covering of soil on naked rocks, and by decomposition produce ammonium.

G. Nees of Esenbeck's spirited treatise on the *Meteoric organizations,* published in 1825, as an Appendix to Robert Brown's miscellaneous botanical writings, vol. i., has given a more definite direction to the examination of this subject. The principal object of this essay was, to place a copious collection of facts in opposition to Chladni's hypothesis, which comprehended only mineral or chemical formations, and which referred to a fancied formation of organic existences in the higher regions of the atmosphere.

In 1826, Professor Fr. Nees Von Esenbeck, the brother of the president, observed an infusory animal as the colouring material of red water, in a vessel of the botanical garden at Bonn, and which, in Kartner's Arch. vii. p. 116, he, along with Goldfuss, his fellow-observer, called *Enchelys sanguinea.* It appeared that the colour of the body of the animal was produced by an internal brown-red granular mass; that the extremities of body were transparent, the hinder pointed, and the fore part rounded. These accounts sufficiently shew that the animal has a similar form with the *Cercaria viridis* of Müller, though the observers say nothing either of the presence or absence of the important dark point in the fore-part of the animal, which Nitsch correctly considers as an eye, and which constitutes the specific character of the genus. Weber at Halle found this point in his red animals, hence there remains no doubt as to the genus. Whether the volvox of Girod Chantran be one and the same, with the *Enchelys sanguinea* has not been determined.

The colouring of water by means of *Oscillatoria major*, or by a species having a close affinity to it, has beeen very recently made known to me, and that species has received from Bory St Vincent the name of *Oscillatoria Mougeotii.*

To the series of observations now concluded, I annex an observation which I made in 1821 and 1823, at Cairo in Egypt. In the months of January and February, I found, in the garden of Mr de Rosetti, on the soil of a place exposed to the morning sun, large spots of from 4 to 6 inches, and of different shapes. These spots seemed so very like clotted blood, that I frequently passed them without being tempted to examine them more closely. The remarkable circumstance of blood being in this part of the garden, at length excited my attention by its abundance, and looking at it again, I took up some of it from the ground with my knife, and soon perceived on the delicately wrinkled surface that it was not blood, but a fungus. The *Thelephora sanguinea* was not known to me; therefore I separated a portion of the mass from the soil, to add it to our collection of plants. On the following day I had leisure microscopically to examine and delineate the fresh plants which I collected from the originals, and will publish in the *Symboli Physici.* The *Thelephora sanguinea,* which is accurately distinguished from the other Thelephorae as a Palmella, but has been inaccurately placed among the Algæ, is distinguished by a real peridium (a firm epidermis) which is entirely awanting in the Egyptian form, which consequently appeared to be of a gelatinous nature. I have described it as a particular genus, and called it *Sarcoderma sanguinea*.

Sarcoderma.—Char. Gen. *Thallus gelatinosus rugulosus granulis discretis repletus nec fibris nec epidermide* (*peridio*) *instructus.* The Nostocinen Algæ have a peridium.

Another kind, the *Geocharis nilotica*, rather of a cinnabar than a blood-red, though of a very lively colour, is universally prevalent in Egypt, on the wet banks of the Nile, where *Riccia glauca* grows. It is a very remarkable kind of small mushroom, having a very close affinity to the *Vaucheria granulata* of Lyngby, or the *V. radicata* of Agardh; but, notwithstanding this, it certainly belongs to the fungi and not to the algæ.

Geocharis. Char. gen. *Thallus tubulosus continuus teres filiformis* (*radiciformis*). *Vesiculæ fructus externæ inflatæ* (*Coniocystæ*) *sporangiis, sporangiis sporidia colorata includentibus repletæ.*

In the same year, I found at Siut in Upper Egypt, after the inundation of the Nile, a stagnant water of a very red colour. The colouring body was the *Sphæroplea annulina* of Agardh, a well-known alga of fresh water.

In 1823, I was for a number of months at Tor, on the Red Sea, in the vicinity of Mount Sinai. On the 10th December I there observed the striking phenomenon of the whole bay which forms the harbour of Tor of a bloody colour. The main sea beyond the coral reef that encloses the harbour, was as usual colourless. The short waves of the calm sea during sunshine, carried to the shore a blood-coloured slimy mass, which it deposited on the sands, so that the whole bay, fully half a league in length at the ebb of the tide, exhibited a blood-red border of more than a foot broad. I took up some of the water itself with glasses, and carried it to my tent at hand on the sea-shore. It was immediately discovered that the colouring was caused by small flakes scarcely distinguishable, often greenish, sometimes of a lively green, but for the most part of a dark-red colour, although the water itself was not stained by them. This very interesting appearance attracted my attention as explanatory of the name of the Red Sea, a name hitherto so difficult of explanation. I for many days, and with perfect leisure, accurately examined the appearance, and made microscopical observations on the colouring mass. The flakes consisted of small spiral, or longish irregular bunches of *oscillatoriæ* threads, which were enclosed in a gelatinous sheath, and the flakes neither resembled one another nor the threads in each flake. In the glasses placed beside me, I observed that the flakes, during the heat of the day and in sunshine, floated together on the surface of the water. During the night, and when the glasses were shaken, they descended to the bottom. After some time they returned to the surface. The observation made by Dr Engelhardt on Lake Murten, was very similar to this appearance, and the delineation of the single threads by De Candolle, exhibits a very close relation to it. De Candolle informs me he has preserved no dried specimen of that substance, for which reason no comparison can be made. The gelatinous covering, and the union of many threads into very small spiral groups, give to the substance of the Red Sea a peculiar character, which entitles it to form a particular genus of alga.

Trichodesmium erythreum. Char. gen. *Fila septata fasciculata nec oscillantia, fasciculi discreti muco involuti sociales libere natantes.* I know a very similar green body, which I have often observed at Leipsic and Berlin, and which entirely fills the water, giving it a greenish hue. I call it *Trichodesmium flos aquæ,* because I do not find it enumerated among the commonly mentioned forms of this kind.

The appearance of the Red Sea was not permanent but periodical. I observed it four times, viz. on the 25th and 30th December 1823, and on the 5th January 1824. We brought along with us for the Royal Collections specimens taken from the sea shore, and dried on paper and sand. More particular details in regard to it will be found in the *Symboli Physici* of Dr Hemprich's journey and my own.

In 1829, I had an opportunity in Siberia of making my most recent observations on blood-red waters. In the steppe of Platow, between Barnaul and the lake of Koliwan, on the 24th July (5th August, O. S.), while intending to take a survey of the vegetation of the steppe, I found a fen with a pool of water, in a low land in the immediate vicinity of the post-station. The dark blood-red colour of the water was very striking, even at a distance. I therefore during breakfast made an excursion to the place of the phenomenon. I found that the colour was confined to a slimy surface, which in different places formed a shining skin. In some places the water was troubled with red colouring matter, which in many places passed into a greenish hue. The red colour was darkest on the edge of the marsh. In some spots, indeed, it formed a red jelly, because the water began entirely to evaporate, leaving nothing but slime upon the mud. The main design of our journey, and the rapidity with which we travelled, prevented me from making microscopic observations on the spot itself, but I collected the red mass partly on white paper, drying it quickly in the sun, and partly in glass bottles; and to make certain of preserving some of it fresh, I took with me some of the mud of the fen coloured with this matter, hoping, on the one hand, that the mud would for a long time preserve the moisture, and, on the other hand, that the small and very probably organic particles of colouring, would remain in it undisturbed, and not be destroyed by the jolting motion of the waggon. In Schlangenberg, where we stopped longer, on the following day, 25th July (6th August O. S.), and on the 27th July (8th August, O. S.), I had sufficient leisure to examine the substance repeatedly with the microscope, and to make a drawing of it. The corpuscula in the mud only were preserved alive, and the microscope immediately shewed that the colouring particles were infusoria, nearly related to the *proteal* forms of the *Cercaria viridis* of Muller, which I have placed in a new genus *Euglena*, but they were not, like these, supplied with eyes, for which reason I have assigned them a new generic name, *Astasia*, from the changeableness of their form. Bory de St Vincent has indeed formed a genus Raphanella, in which he has included similar forms, and likewise the Cercaria viridis; but I omit this name, first bestowed by him from the form of the animal, which is Muller's Proteus tenax. The remaining forms, which are quite differently organized, belong to other genera, and partly to other classes. I shall give a coloured drawing of this beautiful animalcule, done from life upon the spot, in the notices which I intend publishing of that journey, but I shall here be satisfied to make msyelf intelligible by a short characteristic of it.

Astasia, Phytozoa rotatoria. Monotrocha? Char. Gen. *Corpus varium caudatum aut postice acuminatum, ore antico, ciliis non distinctis, oculo nullo.*

It is very probable that this animalcule, which I call *Astasia hæmatodes*, is one and the same with the *Volvox lacustris* of Girod Chantran, but which seems to be still less changeable in its forms, thence must in the mean time be retained as *Astasia lacustris.* A third form is probably the *Astasia sanguinea*, the *Enchelys sanguinea* of Nees and Goldfuss. The structure of this animal has a close affinity to the genus *Euglena*, (Cercaria viridis) that is furnished with an eye, which explains the circumstance why no propagation by division has been observed among them, as is the case in the character of the class of *rotiferous or wheel animals.* I am acquainted with four distinct species of the genus *Euglena: E. viridis*, Cerc. viridis, M. *E. acus*, Vibrio acus, M. *E. pleuronectes*, Cerc. pleuronectes, M.; and a new species, *E. spirogyra.*

Weber's animalcule may form a fifth species, as *Euglena sanguinea.* No more zoological particulars belong to this place.

I close the enumeration of my observations with the information, that during this year at Berlin, the alga-form *Sphæroplea annulina*, in the low lands at Kreutzberg towards Schonberg, the flooded fields at the end of May appeared of a most beautiful orange-colour, which passed into a lively cinnabar, to an extent which I had never before witnessed. This algaform is first green, hence the *Sphæroplea sericea* of Agardh refers to the colour, which was occasioned by Bory de St Vincent's *Cadmus sericeus*, which is just the earlier state of the same plant.

A retrospect of all the facts regarding bodies which really or apparently communicate a red or blood-like colour to waters and aqueous meteors, affords us the following catalogue of them.

A. Blood-dew, Red-dew, Blood-rain, and Red-rain.

I. Are decidedly shewn to be a deception caused

1. By an excretion from bees.
2. from butterflies.
3. By red atmospheric dust.

II. Are probably sometimes effects of chemical processes, producing red rain and red dew, but no particular instances supported by positive and undeniable proof have been adduced by any one.

B. Stagnant red waters (blood water), Red springs, Red Sea-water.

I. Are shewn to be an illusion produced by

a. *Animal Bodies.*

4. Great numbers of Entomostraca } of Daphnia pulex.
5. Great numbers . } of Cyclops quadricornis.
6. . . . } indefinitely minute Akalephæ? in the sea.
7. . . . Infusoria. } of Euglena sanguinea (Weber's infusoria at Halle.)
8. Great numbers . } of Astasia (Volvox) lacustris.
9. Do. do. . . Infusoria. } of Astasia (Enchelys) sanguinea.
10. Great numbers . } of Astasia hæmatodes.

Bleedings of fish are only to be kept in mind for examination.

Red water-spiders (Hydrachna) and Naideæ, have never been so deceptive as not to be immediately recognized, and have never excited the attention of mankind.

b. *Vegetable Bodies.*

11. By Trichodesmium erythræum in the Red Sea.
12. — Oscillatoria rubescens.
13. — Oscillatoria subfusca.
14. — Oscillatoria Mougeotii (Bory), not the Osc. Mougeotiana of Agardh.
15. — Sphæroplea annulina (which is of a cinnabar colour.)

c. *Inorganic Bodies.*

16. — Red atmospheric dust.

II. Are looked upon as a chemical effect produced by the mixing of different kinds of water, the ingredients of which have not been examined.—*Gonsag.*

III. Are looked upon as the operation of volcanic processes on springs.

C. Red moist spots on the ground and on other bodies (blood spots), are shewn to be an illusion caused by plants.

17. By Palmella sanguinea (Thel. sanguinea, Persoon.)
18. — Sarcoderma sanguineum.
19. — Mycoderma (zoogalactina inebrosa.)
20. — Hæmatococcus Grevillii.

21. — Lepraria nivalis, (brick red.)
22. — Geocharis nilotica, (cinnabar red.)

To these belong also the matters already mentioned in regard to red dew and red rain.

D. Blood-jellies are conjectured to be an illusion caused by plants.

Palmella sanguinea.

23. By Actinomyce meteorica rubra.

Besides these twenty-three terrestrial substances and organic bodies, there are, indeed, many other masses and bodies remarkable for red colours, and which might produce similar appearances; but here we have only to do with such as have been viewed as meteoric or blood masses, or whose dense distribution, together with the invisibility of their form, and the striking red colour, which has power to arrest the attention on surveying a district, and assigns a peculiar character to those substances, which, taken singly, are wholly overlooked, and thus seem of no consequence. Let us keep in mind what are the so called colourless organic meteoric substances; and which are as follows;

Vegetable Bodies.

1. Actinomyce meteorice alba (Tremella met.) matter of common falling star.
2. Nostoc commune, as the jewel of the alchemists.
3 Spumaria mucilago, or Æthalium flavum, which comes within this class.

All the observations that are known to me regarding these bodies, especially the first two, excepting the single one from Italy by Menzel, are very unsatisfactory.

b. *Animal Bodies.*

Much has been said about infusoria flying about in the atmosphere; and the existence of meteoric infusoria, assumed as credible, had been made the foundation of other hypotheses, but supported by no direct observations. I know only three observers who maintain this opinion.

Gleichen found infusoria in snow which he melted in his room; and Müller quotes the representation of Kolpoda pyrum (Gleichen S. 150, k. 27, f. 18–20.) Whether the snow was taken as it fell, or somewhere from the ground, is not mentioned, nor whether the vessel and the object glass were intentionally cleaned. As it is probable that Gleichen was interested only in observing the influence of cold on these animalculæ, and in this respect alone found the observation worthy of attention, the proof of its being a meteoric production falls to the ground.

Bory de St Vincent mentions in Dict. Classique, art. Enchelys, p. 158, that he often observed infusoria in snow and drops of rain. As he does not name them, however, we may feel convinced that he did not observe them with particular acuteness.

Professor Schultze, in his work, entitled, Microscopic Examinations of Robert Brown's discovery of Living Animals in all Bodies*, &c. 1828, expresses himself very decidedly, indeed the most decidedly of all. He does not, indeed, speak of meteoric propagation, but supposes, he observed, that the dust hovering every where in the atmosphere was mixed with dried infusoria, among which he perceived the *Furcularia rediviva* (*Rotifer vulgaris*) and *Monades.* These examinations are certainly founded on error. That dried infusoria scattered and floating about as atmospheric dust, or dust from books, can resuscitate, we can no longer believe, being now better acquainted with the structure and peculiar properties of infusoria; and it would be very difficult to recognize a shrivelled rotifera, and particularly to discern its species. I refrain from a full refutation. I make the remark only, that I may, on the contrary, receive instructions from more accurate observations.

To avoid illusion, I have, myself, with uncommon perseverance, and the greatest care, examined upwards of a thousand single flakes of snow and drops of rain and dew, the last two even in the north of Africa; but in no one of them have I, at any time, observed living infusoria. From more accurate observations on the organization of infusoria, I have ascertained that the Rotatoria possess all the organic systems of the higher animals, large eggs, and also nerves; that they are supplied with organs of nourishment, and repeatedly evacuate a granular mass, which cannot be taken for any thing else than eggs. The eggs of the rotatoria are so large, that they cannot escape observation if they are looked for; but it is otherwise with the eggs of the gastric animals (Polygastrica), as I call the rest. These eggs have

* Mr Brown only professed to have discovered *moving* atoms in all bodies, but did not allege that the motion was the result of *life*.—Ed.

$\frac{1}{2000}$, and probably $\frac{1}{8000}$ of a line in diameter. Their minuteness and transparency place them beyond the power of the microscope. It is probable that these eggs, raised by currents of air and the evaporation of water, may fill the atmosphere, and sustain little injury from aridity, because they appear to settle and develope themselves every where, and are perhaps perceptible in the organized matter, the pyrrhine of the atmosphere observed by chemists. But as to living infusoria and meteoric animals, or what are called Atmospheric *Zoophytes*, found in currents of air, we cannot believe in their existence until better evidence than the present is brought forward. The forms not hitherto satisfactorily observed are,

1. Kolpodapyrum, Müller, according to Gleichen.
2. Indeterminate infusoria, according to Bory.
3. Furcularia rediviva,
4. Monas termo,
5. Monas lens,

(3–5) According to Professor Schultze.

Poggendorff's Annalen, No. 4, für 1830.

Outline of a Plan for combining Machinery with the Manual Printing-Press. By John Clerk Maxwell, Esq. of Middlebie*. (With a Plate).

On a former evening of this session, (Jan. 5.) a paper by Mr Fraser, suggesting various improvements on the Art of Printing, was read before the Society, in which, after pointing out the excellency of the Printing Machines, invented by Messrs Cowper and Applegath, and by Mr Napier, for the purpose of publications of large numbers of copies, and where expedition was required, he noticed, that, for fine printing, they were inferior to the manual press, although they excelled in one point, viz. the uniformity in inking, and consequent equality of colour of the printed sheets. He also observed, that, for economy in the case of small publications, the manual presses had the advantage. And concluded by stating, that a contrivance which should give the manual press the benefit of uniform inking, with a diminution of labour, was a desideratum in the art of printing.

* Read before the Society of Arts for Scotland, 2d March 1831.

Mr Fraser says, "As to the inking apparatus, that attached to the machines of Messrs Cowper and Applegath might be placed immediately behind the tympans of the Stanhope or Columbian presses, and be worked by steam-power as at present. Were the tympans and carriage of the press in separate pieces, but made so as to fit very exactly into each other, the carriage might, after each impression, be taken from the hand, on reaching a certain point, by the inking apparatus, and, upon the types being rolled, returned to the same point. In the interim, the pressman could be laying on and off his sheets; and by the time he had done so, the form would again be stationed at his hand, and ready for his taking another impression. It is obvious, that the great difficulty to be overcome here, will be the construction of the machinery for receiving and returning the carriage, and making the carriage so nicely to fit the frame-work of the tympans, as to preserve *register*, as it is called; but after the ingenious contrivance of Mr Napier, in his machine, for receiving and giving off the paper, there can be little doubt of these difficulties being soon obviated. In this way, the great desideratum of securing an equality of colour would be supplied, and the expense of an apparatus for each press, with an engine-power for the whole, would be compensated by only one-half of the men being required."

Having been named a member of the Committee appointed to consider and report on Mr Fraser's suggestions, my attention has been turned to this subject, and some contrivances have occurred to me, which seem fitted, in some degree, to accomplish what has been considered to be desirable. I have now the honour of laying them before the Society, as they occurred to me, thinking, that the shewing of the original conception is better adapted to elucidate the principles of the contrivance, than a description of a more perfect form of machine, with its parts more compactly arranged, and, on that account, more difficult to be described; besides, I conceive the principles of a contrivance more interesting than the details.

If any hint contained in the sequel should prove of use to those who may make trials to effect what Mr Fraser has proposed, it would be a proof of the value of this Society, and of the benefits to be derived from statements like Mr Fraser's, calling attention to what is felt to be wanting to improve any art,—for if my humble endeavours contribute any thing to the art of printing, it is owing to Mr Fraser's paper that my thoughts were turned to the subject.

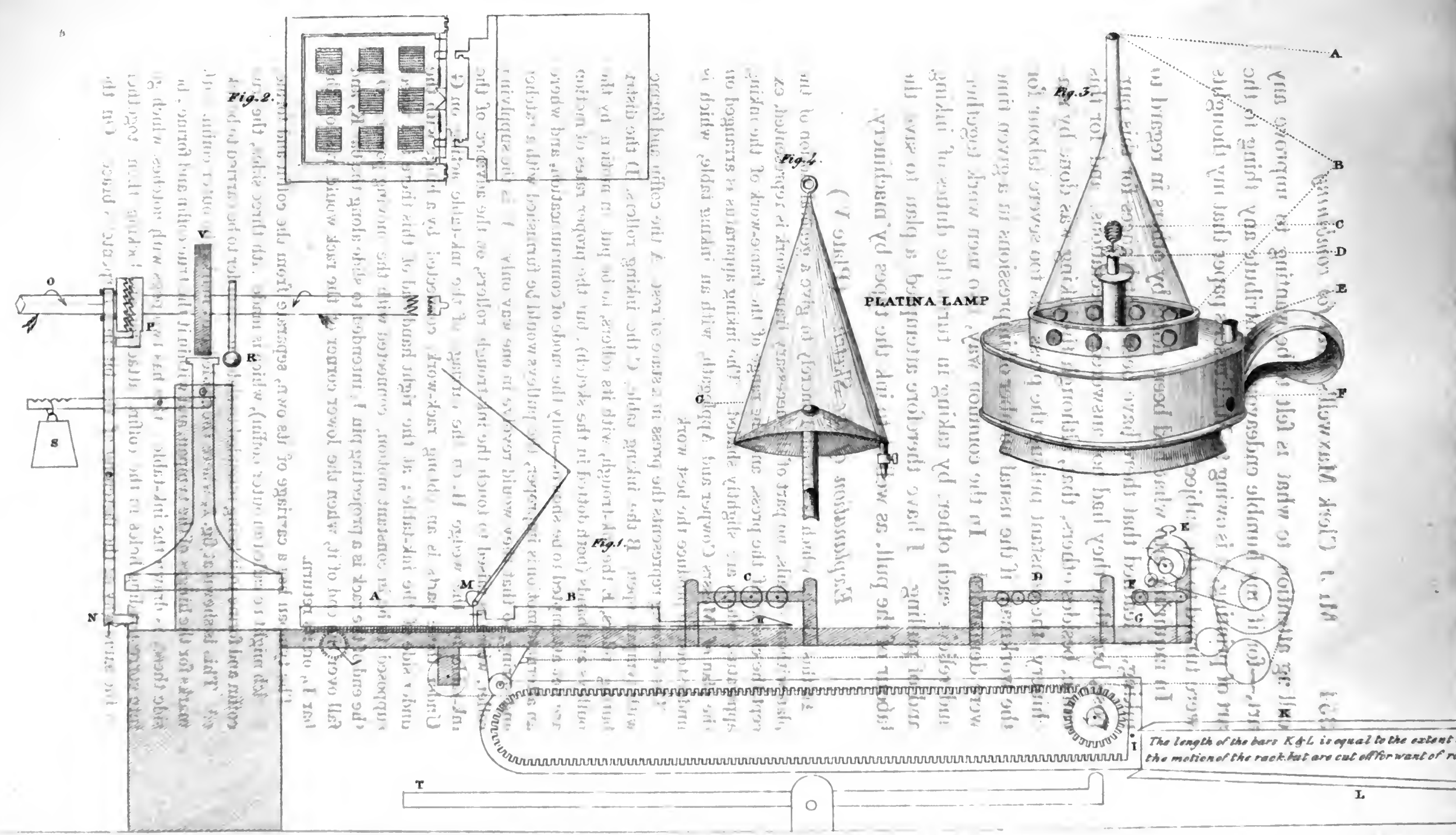
In inquiring into what had been done by others in regard to inking, I learned that there have been contrivances for this purpose, but that they had not answered expectations, and for this cause, besides others, that, although the inking was done by machinery, the constant pulling the press was too severe labour for the workman, if the usual number of impressions in a given time were demanded. In the common way, two men work together, and relieve each other, by taking in turns the duties of inking and of pulling. I have therefore attempted a plan to save the labour of the pull, as well as to ink the types by machinery.

Explanation of the Sketch. (Plate V.)

In this sketch, which is intended merely to give a general notion of the plan without details, no part of the necessary frame-work is represented, except the cheeks of the press, and the range of the frame-work of the inking apparatus, which are slightly shaded. The inking apparatus is arranged on the plan of Messrs Cowper and Applegath, with an inking table, which is understood to produce the best work.

The drawing represents the press in a state of rest. A the coffin and forme, with tympan open, B the inking table, C the inking rollers, D the distributing rollers, E the ink-trough, with its rollers, to be put in motion by the pulleys and bands (both dotted in the sketch); but the proper rates of motion are not attempted to be shown,—only the mode of communication, and where an alternate motion is improper, the pulleys would be furnished with a ratchet and spring, so that they would revolve in one way only. F is the supplying roller, which is raised to touch the ink-trough rollers, on the advance of the ink-table by the wedge H, on the carriage of the ink-table acting on G. Under these parts is an oblong rack-work, connected by a hinge with the under side of the ink-table; at the right hand end of this there is a wheel supposed to be in constant motion, connected with the moving power. On the end of the rack is a projecting pin I, intended to slide along the bar K, and fall over the end of it, when the lower corner of the rack would rest on the bar L, on its return.

The tympan has a carriage of its own, separate from the coffin and forme, (which might be called an outer coffin), which is made with three sides, the true coffin and forme in it being intended to slide out, in order to be carried to be inked. This is shewn at fig. 2, where the shaded part marks the outer coffin, with marks for the hinges of the tympan, and within it the true coffin and forme; beside these, is drawn the ink-table; this has two pegs with notches, which go into corresponding holes in the coffin, attaching and locking them together in the same way as the fastening of the bit in a carpenter's brace. On the



PRINTING PRESS BY JOHN CLERK MAXWELL ESQ[r]

E. Mitchell Sculp.

tympan, as shown in fig. 1, there is a quadrant of a spiral curve M; this is an important part. When the tympan is open, the coffin is free to be drawn out, and it is locked to the inking table; but in shutting down the tympan, this part, by the spiral curved edge, wedges the coffin and forme hard home in the tympan carriage, so as to secure its true position to preserve *register*, and at the same time the sides of the quadrants press back studs which unlock the coffin from the inking table.

The press may be of any approved shape or material, and it has its spindle acted on by an excentric wheel V, which is to be put in motion when the coffin is run home in the press, by its pressing on the end of the lever N, which throws the press into action, the shaft or axle O being in motion from the moving power, and properly sustained by a fly-wheel. The press then descends, and, on its return, the wiper P throws this part out of gear, and at the same time presses back N, which, striking on the coffin, gives the signal for the pressman to run it out. The platten is counterpoised by S, and the excentric wheel by R, so that when free the parts settle in the position ready for action, the wiper P being behind the lever N; on the lower end of N is marked two notches with a round part between them, with a catch pressed upwards by a spring; this is to make the lever N settle in the positions of being quite out or perfectly in gear.

The working of this apparatus by one man would be thus arranged; he would commence with the tympan down, and by acting on the treadle T he raises the rack, so that the pin I may slide along the bar K; the wheel then carries the inking table alone under the inking rollers and others, and returns it to its position; this is to be repeated till it is fully charged with ink, then he opens the tympan and touches the treadle, and the forme is carried off to be inked, while he places white paper on the tympan; the forme being returned to its place and the tympan shut down, he runs it home into the press, the inking table being left at rest. The pressman would bear on the winch till the press falls, and then reverse his action, ready to run the forme out whenever the lever N strikes it back. Having run it back and opened the tympan, he touches the treadle, and proceeds to change the sheet while the inking process goes on, and repeats these operations while he continues to work.

I have thus described the contrivance in its most simple arrangement. The ordinary plans of framing, and all accessories met with in modern machines, are supposed to be used where wanted.

One of the objections most probable to arise at first sight is the inconvenient length of the machine, but this may be obviated in many ways. 1st, If shortness be an object of importance, it can best be obtained by applying those contrivances for inking which do not require the inking table; for if the distribution of the ink be done entirely by rollers, for example such as those used in Napier's machine, then these could be placed in tympan, as shown in fig. 1, there is a quadrant of a spiral curve M; this is an important part. When the tympan is open, the coffin is free to be drawn out, and it is locked to the inking table; but in shutting down the tympan, this part, by the spiral curved edge, wedges the coffin and forme hard home in the tympan carriage, so as to secure its true position to preserve *register*, and at the same time the sides of the quadrants press back studs which unlock the coffin from the inking table.

The press may be of any approved shape or material, and it has its spindle acted on by an excentric wheel V, which is to be put in motion when the coffin is run home in the press, by its pressing on the end of the lever N, which throws the press into action, the shaft or axle O being in motion from the moving power, and properly sustained by a fly-wheel. The press then descends, and, on its return, the wiper P throws this part out of gear, and at the same time presses back N, which, striking on the coffin, gives the signal for the pressman to run it out. The platten is counterpoised by S, and the excentric wheel by R, so that when free the parts settle in the position ready for action, the wiper P being behind the lever N; on the lower end of N is marked two notches, with a round part between them, with a catch pressed upwards by a spring; this is to make the lever N settle in the positions of being quite out of gear or perfectly in gear.

The working of this apparatus by one man would be thus arranged; he would commence with the tympan *down*, and by acting on the treadle T he raises the rack, so that the pin I may slide along the bar K; the wheel then carries the inking table *alone* under the inking rollers and others, and returns it to its position; this is to be repeated till it is fully charged with ink, then he *opens* the tympan and touches the treadle, and the forme is carried off to be inked, while he places white paper on the tympan; the forme being returned to its place and the tympan shut down, he runs it home into the press, the inking table being left at rest. The pressman would bear on the winch till the press falls, and then reverse his action, ready to run the forme out whenever the lever N strikes it back. Having run it back and *opened* the tympan, he touches the treadle, and proceeds to change the sheet while the inking process goes on, and repeats these operations while he continues to work.

I have thus described the contrivance in its most simple arrangement. The ordinary plans of framing, and the various modes of relieving friction, and all accessories met with in modern machines, are supposed to be used where wanted.

One of the objections most probable to arise at first sight is the inconvenient length of the machine, but this may be obviated in many ways. 1*st*, If shortness be an object of importance, it can best be obtained by applying those contrivances for inking which do not require the inking table; for if the distribution of the ink be done entirely by rollers, for example such as those used in Napier's machine, then these could be placed under the gallows of the tympan, and the forme would have to be moved little more than its own breadth. 2d, Supposing the inking table retained, as the method best suited for fine printing, the long rack-work may be superseded by a short one, and the necessary extent of movement effected by the use of wheels and pinions, or by pulleys and bands,—the diameters of the pulleys being so proportioned as to increase the motion; and here it may be observed, that it may probably be found advisable in all cases to interpose pulley and band between the toothed work and the inking table, to free it as much as possible from tremor. 3*d*, Instead of the long rack-work, circular work may be used, either by using alternately the outside and the inside of a toothed circumference, as is done in the Patent Mangle, or by using two wheels, moving in opposite directions, having teeth on one half of their circumference, acting on two lines of rack-work; and if multiplying pulley and band work were interposed between these wheels and racks and the inking table, they might be reduced to a very moderate size.

With regard to the contrivance for working the press, I may observe, that the excentric wheel has the advantage of a motion slow and powerful in proportion, at the first, in order to overcome the *vis inertiæ* of the apparatus of the press, and also at the point of greatest pressure; while it is quicker in the middle parts of the action, both in the rising and the falling of the press; and the resistance of the wiper in throwing the work out of gear, would serve to exhaust the momentum of the excentric wheel, its axles, &c. &c.

In the Sketch, the shaft for putting the press in motion is supposed to pass right over the press, and the excentric wheel to act directly on the spindle of the press; but it is evident the effect may be obtained by the intervention of a lever at whatever distance the shaft may be; and so the contrivance may be suited to any situation, and, instead of acting on the spindle, it might be arranged to move the bar of a common press.

When a few impressions or proofs merely are wanted, the inking apparatus need not be used, the hand-roller, used in the common way, serving instead; and as the inking apparatus and that for working the press have no connection, one or other, or both, may be used at pleasure; and if the press were fitted with a bar, in addition to the excentric wheel apparatus, the press might be used in the common way, when the engine moving-power was not in use.

It may be proper to state the supposed rate of execution of the press I have described. The shaft for the excentric wheel is supposed to revolve once in two seconds, and the wheel of the rack-work once in each second, and that eight revolutions complete the operation of inking. The time necessary to run the coffin into the press two seconds, and the same time to run it out.—Then,

The time of inking, during which also the sheet is taken out, and a white one placed in the tympan, is	8″
Running in,	2″
Pressing,	2″
Running out,	2″
	14″

One impression in 14 seconds gives 256 in the hour.

In the Sketch, the outer coffin, or carriage of the tympan, is supposed to consist of three sides, and without a bottom, and made very thick in the sides for strength. Perhaps it would be better to be made with a bottom, in which case, the winter and range, so far as the tympan carriage has to be moved, must be as much lower than the range for the inking table as the bottom is thick, that the forme may be on the same level as the inking table.

EDINBURGH, *Feb.* 22. 1831.

Note by Mr FRASER.

SINCE the paper referred to by Mr Clerk Maxwell appeared in the last Number of this Journal, it has been satisfactory to learn, that the subject had been also attracting considerable attention elsewhere. Among other communications received, we have been favoured with one from Mr Cowper, and another from Mr Napier, the patentees of the two large printing machines formerly alluded to. The latter gentleman states, that he has already secured a patent for machinery, part of which, although in some degree differing from that proposed by us, is intended for the same purpose, but that he has not yet brought it to perfection; and Mr Cowper says, that his patent for the large machines includes also the application of the inking-apparatus to the common presses, but that he has declined to make such an application, though frequently requested to do so, from a belief that the printer would derive no good from it.

We have also had the pleasure of conversing with Mr Cowper junior, who mentioned that, when lately at Paris, he saw the self-inking apparatus actually attached to the common press, and at work, in the Royal Printing-office there; but that the inking-apparatus was ultimately abandoned, in consequence of the unforeseen obstacle in pulling, which it is one particular object of Mr Clerk Maxwell's invention to remove. Were this part of the latter gentleman's improvement also to be carried into practical effect, not only would equality of colour by the self-inking apparatus be obtained, but also a no less important desideratum be supplied—equality of pressure by steam-power. At present very great muscular exertion is in general required to produce good work, even with very powerful presses; and, therefore, should one or both of the pressmen be unable, or find it difficult, to take a sufficiently strong pull, several devices are apt to be resorted to for lessening the labour, such as *drowning*, instead of merely damping, the paper, increasing the soft substance between it and the point of pressure, applying too much ink, &c., but in all of which cases, however sharp and new the type may be, nothing but a very irregular, blurred, or blunt impression is produced. Hence it will be obvious, that were the means of obtaining a steady, regular, and more or less powerful pressure by steam-power at the common press once procured, it would essentially contribute to the beauty of typography; and hence will likewise be perceived the very great importance of this part of the plan now proposed.

It is curious that, on the other side of the Atlantic, the application of a self-inking apparatus to the common printing press has at the same era been thought of, and carried into effect. In the number of the Christian Instructor for February last, it is stated, that an American Journal, speaking of the improvement in printing, remarks, that "the introduction of the Napier machine into this country, together with the Treadwell press, made at Boston, has been the means of producing quite a revolution in printing. A great variety of machine presses have subsequently been invented here, *and the self-inking apparatus has been improved and applied to the common press.*" "The most rapid machines can be made to strike 5000 impressions in an hour. This is equal to the work of twenty hand presses; or, to express it differently, it will enable us to print the common 18mo Bibles at the rate of 75 copies an hour. A hundred presses at this rate, could supply every family on the earth with a Bible in three years."

For the printing of publications having a large circulation, it has always been obvious that the machines possess a decided superiority over the common presses; but work of this kind is wholly confined to large towns, and even in these to comparatively few printing-offices. By far the greatest proportion of the printing business everywhere consists of work of a miscellaneous nature, and of which comparatively few copies are required. On this account very few printers, indeed, could keep a single machine in constant employment, even were it otherwise applicable to such work, which, neither for general economy nor for very fine work, it is universally admitted not to be. Besides, six good presses can be obtained for the price of one machine, and the great majority of printers throughout the kingdom have seldom or never occasion for so many. These, too, can be applied to a variety of purposes at the same time, and one or more only be used as circumstances may require.

Should a press be at any time unemployed, there is comparatively little loss, for the first cost is not great, and there are no men's wages to pay in the interim; but the very reverse is the case with a printing machine, the original outlay for one, independently of that for the engine, &c., being from L. 400 to L. 700, and a considerable subsequent expense of keeping in repair, and a stated rate of wages to one man and two boys at least. Hence it is evident that common presses must of necessity continue to be in much more general use than printing machines, and could Mr Clerk Maxwell's ingenious improvement upon the presses be carried into effect, there is no doubt of their value and utility being very greatly increased. By it, not only would the labour of one man at each press be entirely saved, but that of the other be also reduced to little more than supplying the sheets of paper. The quality of the work, too, from the regularity of inking and pressure, would be much improved, and means would undoubtedly soon be fallen upon for increasing or diminishing the quantity, in a given time, according to the nature of the work in hand. There would certainly be the additional expense attendant upon an engine, &c. for each printing office, which there is not at present: but surely if the same kind of mechanical power be found more economical and advantageous than manual labour for coffee-grinding, and similar purposes, it would be much more so if it could be rendered applicable to the important operations of miscellaneous letter-press printing. In short, it is very evident that the demand for printing presses and self-inking apparatuses of the kind contemplated would be every where very great, and would soon amply remunerate any one, whether in Europe or in America, who might be so fortunate as to bring them first into effective and economical operation.

Account of a Platina Lamp. By GEORGE MERRYWEATHER, Esq. of Whitby. In a Letter to Professor Jameson. (With a Plate.)

A FEW years ago, Sir Humphry Davy made the discovery, that, if a coil of small platina wire be placed around the wick of a spirit lamp, and rendered red-hot, the wire would continue ignited for a length of time, after the flame was blown out. In consequence of having lately witnessed this singular phenomenon at Professor Hope's lectures, and that it was generally viewed as nothing more than an amusing experiment, I was induced to give the subject some attention, as I felt convinced that a mode might be devised of turning it to some useful purpose.

On the 3d of last month, I contrived an apparatus; but not meeting with the success I expected with platina wire, I made use of spongy platina, which I found to answer the object I had in view. In order that a correct idea may be formed, I have made a drawing of this apparatus. The lower part is constructed of tin, in the body of which is the reservoir, large enough to contain a quart of alcohol; the bottom of the interior of the reservoir is concave, in order that the cotton-wick may take up the last drop of the spirit. After the wick has been spread in the form of a coronet at the top of the lamp, the platina wire cage, containing *one* piece of spongy platina, is to be pricked into the centre of the wick, and to be kept nearly in contact, but not to touch it. After the reservoir has been filled with alcohol, the wick is to be inflamed, and a minute afterwards, the spongy platina will have become incandescent, when the flame is to be suddenly blown out, and the glass cover to be immediately placed over the platina. Without any further care or attention, the platina ball will keep ignited for thirteen or fourteen days and nights. A similar apparatus has been kept ignited for this period in the University of this city. If a tube is connected with a reservoir (containing a sufficient quantity of alcohol), and the bottom of the reservoir of the lamp, I have no hesitation in saying that the platina ball may be kept ignited for years, as the spongy platina does not appear to be in the least deteriorated by being kept in a state of constant ignition.

I had a similar lamp made, on a small scale, to keep ignited from eight to ten hours, which affords sufficient light to shew the face of a watch in the dark of night. It causes no annoyance from a glare of light. If a light is required, the glass cover is to be elevated, and the platina, gently touched with a match of oxy-muriate of potassa, which will be instantly inflamed; and it is no small recommendation, that there is not the least danger to be apprehended from fire.

There have been two objections to this lamp, which were formidable ones, namely, the expense of the alcohol, and the odour which is diffused through the apartment in which it is placed. As a remedy for the first, I find by experiment, that equal parts of alcohol and whisky answer quite as well as pure alcohol; or every one-third of alcohol and two-thirds of whisky do very well, which I find, on calculation, to cost about one penny for eight hours. As a remedy for the second objection, I have contrived an apparatus for condensing the vapour, of which I have made a drawing. In order that it may be correctly understood, I have represented it as transparent; but the apparatus is made of tin, which is to be suspended from a nail in the wall, Fig. 4, G. The glass tube of the lamp is to be inserted into the tin tube of the condensing apparatus, which will completely destroy the strong odour of the vapour. The liquid is drawn off by the stop-cock at the side of the condenser, which will be found a compound of water, acetic acid, and some other peculiar ingredients given to it by the platina.

We may add, that this lamp may prove very useful in all mining districts, as a constant light that may be depended upon, if the reservoir is periodically replenished. If this should be the result, I shall feel myself amply repaid for all the pains I have taken.

EDINBURGH, *March 5.* 1831.

Explanation of Figure of Platina Lamp in Plate V.

Fig. 3. A, Vent for the vapour. B, Glass cover. C, Platina ball. D, Cotton wick. E, Holes for admission of air. F, Reservoir.

Observations on the Fossil Trees of Van Dieman's Land. By William Nicol, Esq. Lecturer on Natural Philosophy*.

Dear Sir,

In compliance with your request, I now give you the result of the examination I have made of the specimens of fossil wood you have lately received from your friend Colonel Lindsay, at present in New Holland †.

Thin transverse sections of each were formed on the method I have adopted, and which I have described minutely in a work lately published by Mr Witham on the Structure of Fossil Wood. On viewing these sections, by help of a microscope, or even a common pocket lens, it is sufficiently obvious that five of the specimens belong to the family of Coniferæ, and two to the tribe of true Dicotyledons. Four of the coniferæ are common wood-stone, the fifth is wood-opal. One of the dicotyledonous specimens is wood-stone, and shews the organic structure throughout the whole mass; but the other specimen, which is in the state of opal, shews the organic structure only in certain parts of the mass. In such parts, there is a peculiarity which I do not recollect to have seen in any other specimen of petrified wood; and which is, that the pores or vessels, instead of being filled with petrifying matter, are perfectly empty. Throughout the greatest part of this magnificent specimen, the vascular struc-

* Read to the Wernerian Society, 5th March 1831.

† In examining the structure of petrified woods, it has been the practice to shew it either by simply cutting and polishing the surface, and examining it by reflected light or by cutting thin slices, and examining them by transmitted light. This latter, although the best mode, has hitherto afforded less satisfactory results than it ought to have done, owing to the imperfection of the cutting and polishing process. Mr Nicol, after much labour, has succeeded in so perfecting this process, as to enable us by it to shew, in an elegant and beautiful manner, the most minute structures of fossil, and also of recent vegetables. The plates in Mr Witham's book on "Fossil Trees," shew what may be effected by this process. We doubt not that it will also be generally used by botanists in their examination of the structure of recent woods; for, as well remarked by Mr Nicol, this structure may afford means of arrangement of plants hitherto but little attended to. We have always maintained that the internal structure of plants might, to a certain extent, afford the means of scientific arrangement of the groups of the vegetable kingdom.—Edit.

ture is quite obliterated, and the ligneous origin can barely be inferred from very slight traces of annual rings. Some parts have a fibrous structure, and are white and opaque. The fibres cohere so slightly in some portions, that they may be reduced to powder between the finger and thumb. In general, however, the fibres cohere more firmly as they approach the translucent part, and then the vegetable structure becomes very apparent.

In addition to the above specimens, I have in my possession other two from Van Dieman's Land. These are both Coniferæ, so that out of nine specimens seven are Coniferæ, and only two true Dicotyledons. As far as these nine specimens go, we may therefore infer, that in Van Dieman's Land the growth of coniferous trees at a period antecedent to the present state of things, was more frequent than that of the Dicotyledonous kinds. The same may be said with regard to the Coal and Lias formations of this island. In these deposits numerous specimens of petrified wood have been found, and, from a careful examination of these, I will venture to assert that the whole belong to the coniferous tribe. This opinion you will probably remember I mentioned to you, Mr Witham, and others, in the course of last summer, and I was then led to speak on the subject with some degree of confidence, from a recent investigation of the structure of the different kinds of trees at present growing in all the different climates of the globe. In order to obtain the requisite knowledge, I found it necessary to cut transverse sections of a great number of trees, and of such a degree of thinness, that the cellular, as well as the vascular, system might be distinctly seen. This labour I was obliged to submit to, in consequence of finding all the sections of wood figured in such works on vegetable anatomy as I could lay my hands on so imperfect, that no precise idea could be formed on the subject.

The structure of the Coniferæ differs so widely from that of the true Dicotyledons, that a single glance will in general enable us to distinguish the one tribe from the other. In the Coniferæ there is only one regular system of pores, resembling a piece of the most delicate network. Each mesh is bounded by straight lines crossing each other at nearly right angles, and the concentric lines of the meshes almost always approximate each other at the outer edge of each annual layer of the wood. This structure is uniform throughout the whole tribe of Coniferæ, the only perceptible difference consisting of the dimensions of the meshes, trees of slow growth, as Taxus Baccata, having the finest texture. It may be right to mention, that in some of the Coniferæ, (not in all), there are occasionally circular openings to be seen, known to botanists under the name of Lacunæ. These, however, are very irregular in their distribution, sometimes occurring frequently, at other times not at all.

The structure of the true Dicotyledons consists of a system of vessels separated from one another by masses of cellular matter. The vessels or pores are always bounded by curve lines. In some trees they are circular, in others they are elliptical, and the degree of eccentricity of the ellipses in different trees is remarkably different. The elliptical pores are sometimes divided by one or two transverse partitions. In some trees the vessels are empty, and in other trees they are filled with a resinous or gummy-resinous matter. The size, form, number and arrangement of the vessels or pores differ so widely in different trees, that one species may be as clearly distinguished from another by the organic structure as by the shape of the leaves or the florification. As in the Coniferæ, the vessels generally become smaller as they approach the outer edge of the annual layers. In some kinds of trees the vessels are numerous, in other kinds they are sparingly bestowed; and it is worthy of note, that, in some kinds of wood of great strength and durability, as the oak, they are not only numerous, but also of very large dimensions.

The cells constituting the cellular portion of Dicotyledonous trees, have different forms and different dimensions in different kinds of wood. In the coarser kinds of mahogany for instance, the cells have a rhomboidal form. In some trees they are spherical, and in others the form is very irregular; but however the form may differ, it will in general be found that the smaller the cells the greater will be the strength of the timber. This is very strikingly the case with regard to the different kinds of elm. In the Scotch Elm the cells are smaller than in the English Elm, and these, again, are smaller than in the Dutch Elm; and it is generally known the timber of the Scotch Elm is better than that of the English, and that the Dutch Elm is good for nothing.

With regard to the two specimens of petrified wood from the tertiary formation of the Isle of Sheppy, I have only to remark, that they both belong to the coniferous family. One of them displays the concentric rings surrounding the pith very distinctly, but throughout the greater part of the mass there are only fragments of the reticular texture to be seen intermixed with calcareous spar, in the form of stellular radiated concretions. In the centre of many of these concretions there are a few meshes of the net-work of the wood, and which have probably disposed the calcareous matter to assume its present form.

These specimens, when in the woody state, have been penetrated by worms in a manner similar to what takes place at the present day, and the cavities so formed have been filled with calcareous spar and sulphuret of iron. Yours faithfully,

Wm. Nicol.

Professor Jameson, College Museum.

Edinburgh,
March 5. 1831.

Account of the Discovery of Bone Caves in Wellington Valley, about 210 miles west from Sydney in New Holland.

Dr Lang of Sydney *, at present in this country, having communicated to us the following particulars, in regard to the remarkable bone-caves of New Holland, we hasten to lay them before our readers, as they are highly interesting in a geological view. A description of the collection of bones from these caves, mentioned in the following communication, will be given in our next Number. Among these remains of a former mammiferous creation, are bones of an animal very much exceeding in size any of the existing races in New Holland.

Sir, *Sydney, 21st May* 1830.

I beg you will allow me to inform your readers that a discovery, which will doubtless excite very considerable interest

* We are delighted to learn that a College Academy is about to be established at Sydney. With such a man as Dr Lang as chief, it cannot fail to flourish, and prove beneficial to the Australian world.

in the scientific world, both in Great Britain and on the continent of Europe, has just been made in the interior of this Colony, by that very respectable Colonist and Magistrate, George Rankin, Esq. of Bathurst. The discovery I allude to is that of a great quantity of fossil bones, in a cave near the penal settlement of Wellington Valley, and about 210 miles west from Sydney.

The country in the neighbourhood of Wellington Valley is of limestone formation, and the limestone ridges are perforated by numerous subterranean caverns, branching off in every direction, and forming chambers of the most grotesque, and at the same time of the most imposing appearance. This remarkable feature in the physical conformation of that part of the territory is not peculiar, however, to the limestone ranges of Wellington Valley. Similar caves are met with in Scotland, in Yorkshire, and in other parts of Great Britain, on the continent of Europe, in North America, and in short, wherever limestone abounds.

In a late excursion to Wellington Valley, Mr Rankin visited and explored a remarkable cave, about two miles from the settlement, the existence of which had been known for a considerable time, and the entrance of which is in the face of the limestone range, on the south side of the river Macquarrie, by a gentle declivity. Immediately beyond the entrance, the cave in question expands into a lofty and spacious chamber, the roof of which is beautifully ornamented with stalactites, many of which, however, have unfortunately been broken off by the *scientific barbarians* of the neighbouring settlement. In beating gently with a hammer on the sides of the cavern, the sound in one part of it indicated the existence of another chamber separated from the first by a thin partition; and accordingly, on breaking through the thin dividing wall of limestone, a second chamber was discovered, though of smaller dimensions than the first. At the farther extremity of the first chamber, Mr R. discovered a downward passage, which he determined to explore, and which he found terminated in another cave or chamber, the entrance into which was by a precipitous descent. On lowering himself down into this third chamber, into which no mortal man had ever entered before (for the aborigines have a superstitious repugnance to entering any cavern, saying, *Koppa*, the spirit of the caves in the aboriginal mythology, *Koppa sit down there*), Mr R. observed, to his very great surprise, a piece of bone lying on the floor of the cavern. It struck him at first that it might have belonged to some bush-ranger who had attempted to hide himself in the cave, and had subsequently died; but on a more minute examination, he discovered a vast number of other bones of various sizes, and generally broken, some strewed on the floor of the cave, but the greater number imbedded in a sort of reddish indurated clay along its sides. The rope by which he had lowered himself into the cavern had been fixed to what appeared a projecting point of the solid rock, but on its breaking off in consequence of the weight attached to it, it was ascertained to be a large fossil bone—the thigh bone, I conceive, of some quadruped much larger than the ox or buffalo, and probably of the Irish elk, the rhinoceros, or elephant.

Mr Rankin collected a small quantity of the bones, or rather fragments of bones, and has brought them to Sydney, with a view to their being forwarded to Professor Jameson, of the University of Edinburgh. They will doubtless excite much interest among the geologists of Great Britain, and will probably lead to interesting results, in regard to the geological history of this vast island. It may perhaps be deemed presumptuous for an individual, who has little acquaintance with the science of comparative anatomy, and none whatever with that of fossil osteology, to anticipate these results. But the discovery in question has developed certain facts of the utmost interest in regard to the past history of the continental island, from which certain inferences, which it would be difficult to dispute, are clearly deducible. These facts and inferences I shall therefore take the liberty to submit to your readers.

1. It is quite evident that the greater number of the bones in question are not those of animals of the species at present inhabiting this territory. The aborigines are very good authority on this point in the absence of such men as Professor Jameson, or Professor Buckland, or Baron Cuvier; for when shewn several of the bones, and asked if they belonged to any of the species at present inhabiting the territory, they uniformly replied, *Bail that belongit to Kangaroo, Bail that belongit to emu*, &c. &c.

2. It is equally evident that the bones in question have been brought to their present locality by some beast of prey; for no other supposition will account for the cavern's becoming the general cemetery for animals so various in size, and so different in habits, as those to which they must have once belonged.

3. It is not less evident that the animals that owned these bones could not have died a natural death, for most of them have evidently been subjected to great violence, and exhibit fractures in every direction. The floor of the cavern is strewed over with a sort of dust, consisting of minute fragments of decomposed bone, which burns readily when ignited.

In short, there is reason to believe that the cave at Wellington Valley is somewhat similar to the one which Professor Buckland examined at Kirkdale, in the north of England, and which he ascertained, beyond the possibility of doubt, to have been the den of a hyæna (resembling the variety now existing only at the southern extremity of Africa) before the deluge. Both of these caves are in limestone ranges. They both contain innumerable fragments of fossil bone, deeply imbedded in stalagmite—the substance formed from the droppings of water in caverns of the kind in question—or in indurated clay. I cannot pretend, however, to describe either the nature or the relative position of the substance in which the bones at Wellington Valley are imbedded, having only seen a minute portion of it adhering to one of the bones.

From these ascertained facts, I conceive we are warranted to deduce the following inferences:—

1. That this vast island is not of recent or post-diluvian formation, as is generally asserted, without the least shadow of evidence.

2. That at some former period of its history it was inhabited by various races of animals, that are either extinct or no longer existing in this part of the world.

3. That the physical convulsion that destroyed these various races of animals did not materially change the external appearance of the country; for the wild beasts' (probably the hyænas') den at Wellington Valley has in all likelihood the very same appearance that it had when inhabitated upwards of four thousand years ago.

While this very interesting discovery supplies us, therefore, with another convincing proof of the reality and the universality of the deluge, it supplies us also with a powerful motive of gratitude to Divine Providence for that long-forgotten visitation. For if this territory were over-run with such beasts of prey as the antediluvian inhabitants of the cave at Wellington Valley, it would not have been so eligible a place for the residence of man as it actually is. The tiger or hyæna would have been a much more formidable enemy to the Bathurst settler than the despicable native dog, though indeed they would certainly have afforded a much nobler game to the gentlemen of the Bathurst Hunt. And if the huge rhinoceros had inhabited the lagoons of Hunter's River, it might have been a much more serious work to displace him to, than shoot the pelican or emu.

I cannot conclude this letter without expressing my unfeigned regret that, while this territory is becoming daily more and more interesting to the geographer and geologist, to the man of science as well as to the agriculturist and the merchant, the interesting youth of Australia should hitherto have been debarred, in consequence of their want of instruction in the various branches of Natural History and Natural Philosophy, from prosecuting the numerous and interesting paths of discovery which this vast island presents to every man of science and reseach. Could a Lecturer not be established in Sydney under the patronage of the Sydney College? There are surely men in this Colony not less able than our brethren in Van Dieman's Land, to give a course of Lectures that would interest, instruct, and stimulate the youth of Australia. I am, Sir, your most obedient Servant,

L.

TO THE EDITOR OF THE SYDNEY GAZETTE.

Additional Information illustrative of the Natural History of the Australian Bone-Caves and Osseous Breccia. Communicated by Dr. Lang.

These bones are found embedded in a red ochreous cement, which occurs partially in the crevices of the limestone rock, in different parts of the interior of New South Wales.

The limestone rests on granite, and generally near, or under, trap-rock. In the particular spot whence these specimens are brought (Wellington Valley), the rock, partially denuded, bounds an extensive alluvial flat, through which the River Bell runs, this being a branch of the river Macquarrie, which it joins seven miles below. Beyond, or above the limestone, on one side, the hills enclosing the valley consist entirely of trap-rock. Those on the other rise higher, and consist of the old red sandstone (fine grained, with tendency to crystallization), and passing, as the hills rise backward, into a conglomerate of water-worn pebbles strongly cemented, and so much inclined, that the rock terminates the summits in sharp rocky crests.

Throughout the country, the limestone occurs adjoining alluvial flats, the hills above consisting of trap. In the parts most denuded, openings are found leading to caves, some of which are spacious, with varied forms of stalactites, sometimes disposed in a very picturesque manner. The floor generally consists of a soft red earth, apparently diluvial, but in which, after digging, few or no bones have been found, none having as yet been dug up where the floor has been encrusted with stalagmite. The entrance is generally in the side of the rock and gently inclined. The holes where the osseous breccia occurs are generally near such caves, yet *separate from them;* the mouths (in three cases in different parts of the country) appearing like pits, and as if formed by the rocks and earth sinking or sliding downwards. The interior of these holes presents a striking contrast to the unbroken harmony of the other kind of caves. Here disjointed masses of rock hang suspended in this remarkable red cement, which is sometimes as hard as limestone, and which is never without bones embedded. Frequently these occur so fixed between large rocks, that it is quite impossible to get them out; and indeed, in general, none can be got in an entire state from the matrix, being, in their embedded state, full of fractures; and it is remarkable, that the few large bones at all perfect, have been found projecting from the upper surface of the breccia; from which circumstance, and the peculiar outward texture (something resembling the clay of a swallow's nest), it would appear that this cement never was so soft since mixed with the bones, as to admit of the larger bones sinking downwards in it. In such caves the red cement with bones pervades all the crevices as far as they can be penetrated, which is generally very directly downwards. One chamber of the cave, whence these specimens have been taken, was terminated by the cavity being stopped up with soft diluvial earth, while the breccia formed the roof, and adhered to the limestone rock forming the sides, and appeared separated from the loose earth of the lower part by three layers (like strata) of limestone, about an inch in thickness, and three inches apart between, and in which the bones were in greatest abundance, and generally upright, or having one end in each layer.

The peculiar texture of the cement, led to a search for it on other parts of the surface above limestone, and in other parts of the country, and it was found precisely under the same circumstances as at Wellington Valley.

1. Six miles north-east, on the opposite side of the Macquarrie.

2. At Buree, fifty miles south-east; and, on looking at some denuded limestone-rock similarly situated in another place (Molong), a small quantity was also detected in a crevice like an oven; which also when broken contained small bones.

The most remarkable facts connected with these bones, and this breccia, seem to be,

1*st*, That it occurs only in the neighbourhood of caves, but yet distinct from those of the most open and permanent description.

2*dly*, That although always reaching to the surface, it is distributed deeply and extensively in the crevices of the limestone.

3*dly*, That this particular substance never occurs, but in combination with bony fragments; that bones occur in such quantity in this cement only; that those of small and large animals are intimately mixed; and that, although much broken, there is no appearance of their being water-worn, but that, on the contrary, small angular fragments of bone like saw-dust are combined in such quantity in some caves, as to give a light speckled colour to the cement, which is, by itself, red and ochreous.

4*thly*, That in one case, where this cement was traced to the surface, a large fragment or rock of it, as hard as limestone, lay above, having deeply embedded in it several bones apparently human; this rock indicating an antiquity almost as high as the limestone rock itself, for the breccia is so combined in parts, that its removal would occasion the rocks to collapse, so as materially to alter the external surface and form of the hills.

It is proper to add, that some fragments of bones have been found by digging in the loose earth of most of the caves, but from their imperfect state, and the vicinity of the breccia outside, it is difficult to determine whether they might not have originally belonged to it or not.

It appears from the description by Major Imrie, of the red ochreous cement containing bones which occurs at Gibraltar, and along the northern shores of the Mediterranean, that this breccia is of the same kind both *in situ* and character, and that its antiquity is at least equal to, if not much higher, than the bones found under stalagmite in caves, in different parts of Europe.

Description of several New or Rare Plants which have lately flowered in the neighbourhood of Edinburgh, and chiefly in the Royal Botanic Garden. By Dr GRAHAM, Professor of Botany in the University of Edinburgh.

10*th March* 1831.

Banksia littoralis.

B. *littoralis;* foliis elongato-linearibus, spinuloso-dentatis, basi attenuatis, subtus aveniis; calycibus deciduis; folliculis compressis bracteisque strobuli apice tomentosis; caule arboreo, ramulis tomentosis.—*Brown.*

Banksia littoralis, *Br.* in Linn. Soc. Trans. 10. 204. ?—*Id.* Prodr. Fl. Nov. Holl. 392. ?—*Rœm. et Schultes*, 3. 438 ?—*Sprengel*, Syst. Veget. 1. 485. ? excl. syn.—Bot. Reg. 1363.

DESCRIPTION.—*Shrub* erect. *Branches* ascending, purple, villous. *Leaves* scattered, pubescent when young, naked and dark green above when old, densely covered with snowy tomentum below, on short erect petioles, linear, truncated, spinuloso-serrate, avenous, slightly revolute in the edges. *Amentum* (4 inches long, 3 inches broad to the extremity of the styles) terminal, upon a short leafy peduncle, the branches rising far above it from a whorl at its base. *Flowers* in pairs, forming double rather distant lines along the rachis, with which, when fully expanded, they form nearly right angles, expanding from above downwards. *Bracteæ* tomentous, green where exposed, yellow where included, either solitary, rhomboid, subacute, with the apex turned up, when they are placed between the pairs of flowers, or geminate and rounded, and placed above or below them. *Calyx* 4-parted, covered with adpressed pubescence; claws linear, yellow, the spoon-shaped segments of the limb reddish, nodding. *Anthers* elliptical, subsessile in the cavities of the calyx. *Style* twice as long as the calyx, shining, of deep purple colour except at the base and apex, where it is yellow, deciduous, rigid, apex nodding. *Stigma* an abrupt glandular scarcely swollen termination to the style, retained for some time within the calyx, and, when liberated, covered with the yellow granular pollen, which gives it a capitate form.

This species flowered in the greenhouse of the Botanic Garden in November 1830, immediately after *B. speciosa*, and remained in flower, forming a good contrast with this in its colours and manner of flowering. It seems quite different from *Banksia microstachya* of Cavan, and *B. attenuata* of Brown, with both of which Sprengel unites his *B. littoralis*.

I have assigned the specific name to this plant doubtfully, and have quoted all the authorities cited above with hesitation, except the Botanical Register, because I have some reason to doubt its identity with the plant sent from New Holland by Mr Brown, and cultivated at Kew under the name of *B. littoralis*. The specimen which flowered with us we received from Mr Mackay at Clapton in 1828, without any name; and in 1829, we received from him a seedling, which has proved to be the same, under the name of *B. collina*, from which, however, it differs, in being destitute of veins on the back of the leaf. I have a specimen from Mr Fraser of a species which must stand very near to it, and is chiefly distinguished by the leaves being longer, narrower and quite entire, except near the apex, where there are four small teeth, and by the branches being much less hairy; in colour and manner of flowering it perfectly agrees. It must also in many respects agree with *B. marginata*, but differs from this in the bracteæ being tomentous.

Leria nutans, DC.

L. *nutans*; scapo unifloro, laterali; flore nutante; foliis runcinato-lyratis, medio contractis, undulatis, dentatis, subtus tomentoso-niveis, lobo terminali cordato-oblongis.

Leria nutans, *Spreng.* Syst. Veget. 3. 502.
Tussilago nutans, *Willd.* Spec. Plant. 3. 1965.
Dens Leonis folio subtus incano, flore purpureo, *Sloan*, Jamaica, 1. 255. t. 150. fig. 2.
Tussilago scapo unifloro, foliis lyrato-ovatis, *Plum.* Plant. Amer. fasc. 2. t. 41. fig. 1.

Description.—*Root* perennial. *Leaves* (3 inches long, 1¼ broad) all radical, spreading, recurved, runcinato-lyrate, undulate, veined, toothed, green and nearly naked above, densely covered with snowy tomentum below, contracted in the middle, below which they are very narrow and much sinuated; above the middle they are cordato-oblong, and more entire. *Scape* (6 inches high) lateral, erect, single-flowered, covered with snowy tomentum, especially above, destitute of scales. *Flower* nodding, white, or with a slight shade of purple. *Anthodium* imbricated, subcylindrical, scales subulate-linear, with a strong green middle rib, and tomentous membranous edges. *Receptacle* naked. *Florets* of the *ray* slender, female, ligulate, trifid, longer than the *styles*, which are bifid, having the stigmatic surface along the inside of the segments. *Florets* of the *disk* shorter than the ray, slender, 5-toothed, sub-bilabiate, the throat being slightly gibbous, and the division of the limb less deep on one side; *stamens* as long as the corolla. *Style* and *stigma* exserted, their structure as in the ray. *Germen* pubescent. *Pappus* stipitate, slightly rough.

This plant was raised at the Botanic Garden from seeds obtained by Captain Bennet, R. N. from the West Indies in 1827. It has flowered in the stove in March last year and this. It has no beauty, nor can it be attractive in cultivation, though Sloan attributes to it many virtues in very different cases, concluding the whole by stating, that "it is a remedy against all sorts of cold, for it is hot and bitter."

Elephantopus sericeus.

E. sericeus; caule piloso; foliis ovato-oblongis, subacutis, base attenuatis, crenato-serratis, supra leviusculis, glabriusculis, subtus mollissime piloso-sericeis; paniculo diffuso; bracteis subcordato ovatis, acutis; involucri foliolis exterioribus subulatis, interioribus tubam corollæ æquantibus.

Description.—*Root* perennial. *Stem* (2 inches high) erect, short, branched, leafy, covered with white erect hairs. *Leaves* (5 inches long, 1½ broad) ovato-oblong, spreading, unequally crenato-serrate, attenuated at the base, and at the insertion stem-clasping, dark green, and slightly covered with soft down above, below thickly covered, especially on the veins (which are numerous and prominent) and their primary divisions, with coarse yet soft somewhat silky hairs; middle rib very strong and prominent on both sides, especially below; leaves on the flower-stalk few, scattered, gradually smaller upwards. *Flower-stalk* (1½ foot high) terminal, erect, slightly flexuose, leafy, tapering, panicled, pubescent. *Panicle* loose, the branches rising from the axils of the diminished leaves, erect. *Bracteæ* subcordato-ovate, acuminate, single, except from the confluence of several capitula at the extremities of the branches. *Involucre* about 4-flowered, of few leafets, the four inner subequal, lanceolate, 3-nerved, membranous at the edges, very slightly pubescent on the outside, hard and chaffy, outer leafets much shorter than these four, subulate. *Corolla* small, white, glabrous; tube equal in length to the involucre, curved, very slender, slightly dilated at the throat; limb 5-parted, segments secund, slightly callous at the apices. *Pistil* subexserted; germen green, obovate. *Pappus* of 5 simple hairs, very slightly dilated at the base.

This species was raised from seed sent to the Botanic Garden by Dr Krous of Dominica in 1829. It has been added to Dr Hooker's herbarium from St Vincent and Trinidad. It is distinguished from *E. Martii* by the form of its leaves; by its much less hairy flower-stalk; by the form of inflorescence; by the greater length of the involucra; and by the narrow more acuminate bracteæ. I think it is distinguished from *E. mollis* of Kunth, by the form of the bracteæ, and of the outer leafets of the involucre; by its leaves being nearly even on the upper surface; and by their being only moderately attenuated at the base, certainly less so than in some other species of the genus.

Celestial Phenomena from April 1. to July 1. 1831, calculated for the Meridian of Edinburgh, Mean Time. By Mr George Innes, Astronomical Calculator, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

APRIL.

D.	H.	′	″	
1.	2	43	30	☌ ☽ γ ♎
1.	14	10	20	☌ ☽ ψ ♎
2.	6	27	21	☌ ☽ φ Oph.
5.	11	52	52	☾ Last Quarter.
5.	13	58	35	☌ ☽ d ♐
6.	7	35	–	Sup. ☌ ☉ ☿
7.	20	23	13	☌ ☽ ♅
8.	0	48	42	☌ ☽ ♃
8.	22	28	56	☌ ♂ 1 ♉
9.	16	20	15	☌ ☽ λ ♒
10.	2	3	31	☌ ☽ φ ♒
12.	1	13	16	☌ ♀ δ ♈
12.	15	48	54	● New Moon.
13.	1	27	0	☌ ☽ 2 ξ Ceti.
13.	3	35	–	☌ ☽ ☿
13.	20	16	44	☌ ☽ μ Ceti.
14.	11	56	50	☌ ☽ ♀
14.	14	48	53	☌ ☽ f ♉
15.	10	10	30	☌ ☽ γ ♉
15.	11	22	7	☌ ☽ 1 δ ♉
15.	11	49	40	☌ ☽ 2 δ ♉
15.	16	30	31	☌ ☽ α ♉
16.	11	3	8	☌ ☽ ♂
17.	12	55	10	☌ ☽ ν ♊
19.	6	13	44	☽ First Quarter.
20.	20	35	50	☉ enters ♉
21.	7	26	40	☌ ☽ ♄
21.	11	22	32	☌ ☽ α ♌
21.	23	2	10	☌ ☽ ρ ♌
22.	16	9	18	☌ ♀ A ♉
22.	16	44	–	☿ near δ ♈
22.	22	48	4	☌ ☽ σ ♌
24.	15	57	7	☌ ☽ 1 γ ♍
25.	3	31	16	Im. I. sat. ♃
25.	15	38	37	☌ ♂ 132 ♉
26.	17	25	7	☌ ♀ 2 κ ♉
27.	0	3	55	○ Full Moon.
27.	7	5	16	☌ ♃ ε ♑
28.	9	29	48	☌ ☽ γ ♎
28.	10	44	–	☌ ☿ η ♉
28.	20	54	37	☌ ☽ ψ ♎
29.	13	13	0	☌ ☽ φ Oph.

MAY.

D.	H.	′	″	
2.	21	2	4	☌ ☽ d ♐
3.	6	0	–	☿ greatest elong.
3.	18	4	30	☌ ♃ γ ♑
4.	17	40	26	☌ ☽ ♅
5.	3	18	34	☾ Last Quarter.
5.	16	10	42	☌ ☽ ♃
7.	1	36	4	☌ ☽ λ ♒
7.	11	35	18	☌ ☽ φ ♒
9.	4	43	55	☌ ☽ ν ♓
11.	0	10	31	☌ ☽ 2 ξ Ceti.
11.	6	58	51	☌ ☽ μ Ceti.
11.	23	44	28	● New Moon.
12.	19	17	35	☌ ♀ 132 ♉
12.	20	16	0	☌ ☽ γ ♉
12.	21	24	43	☌ ☽ 1 δ ♉
12.	21	53	37	☌ ☽ 2 δ ♉
13.	2	18	–	☌ ☽ ☿
13.	2	24	26	☌ ☽ α ♉
14.	9	13	55	☌ ☽ ♀
14.	21	26	20	☌ ☽ ν ♊
15.	2	22	13	☌ ☽ ♂
15.	18	28	14	☌ ♂ ε ♊
18.	14	0	7	☌ ☽ ♄
18.	17	12	0	☌ ☽ α ♌
19.	4	42	8	☌ ☽ ρ ♌
19.	15	55	55	☽ First Quarter.
20.	4	17	3	☌ ☽ σ ♌
21.	20	49	44	☉ enters ♊
21.	21	28	52	☌ ☽ 1 γ ♍
23.	3	31	36	♀ near ε ♊
24.	2	20	13	☌ ♃ δ ♑
25.	15	34	7	☌ ☽ γ ♎
26.	3	0	17	☌ ☽ ψ ♎
26.	12	22	–	Inf. ☌ ☉ ☿
26.	15	44	45	○ Full Moon.
26.	19	19	20	☌ ☽ φ Oph.
29.	4	43	5	☌ ♂ δ ♊
30.	1	18	22	Im. III. sat. ♃
30.	3	0	14	☌ ☽ d ♐
31.	19	18	51	☌ ♀ ♂

JUNE.

D.	H.	′	″	
1.	11	48	6	☌ ☽ ♅
2.	2	22	17	☌ ☽ ♃
3.	1	56	1	Im. I. sat. ♃
3.	8	55	0	☌ ☽ λ ♒
3.	15	4	24	☾ Last Quarter.
3.	19	11	40	☌ ☽ φ ♒
6.	14	25	19	☌ ☽ ν ♓
7.	2	10	26	Im. II. sat. ♃
7.	10	22	40	☌ ☽ 2 ξ Ceti.
7.	17	19	11	☌ ☽ μ Ceti.
8.	11	56	30	☌ ☽ f ♉
9.	1	16	–	☌ ☽ ☿
9.	7	3	8	☌ ☽ γ ♉
9.	8	13	58	☌ ☽ 1 δ ♉
9.	8	39	57	☌ ☽ 2 δ ♉
9.	13	13	50	☌ ☽ α ♉
10.	6	37	31	● New Moon.
11.	7	44	5	☌ ☽ ν ♊
11.	21	0	54	☌ ☽ ζ ♓
12.	18	13	51	☌ ☽ ♂
13.	5	53	17	☌ ☽ ♀
15.	0	23	42	☌ ☽ ♄
15.	0	45	45	☌ ☽ α ♌
15.	11	56	16	☌ ☽ ε ♌
16.	9	15	0	☌ ♀ γ ♋
16.	10	56	57	☌ ☽ ε ♌
17.	3	17	2	☽ First Quarter.
17.	19	55	–	☌ ♄ α ♉
18.	3	32	2	☌ ☽ 1 γ ♍
18.	19	34	–	☌ ☿ 1 δ ♉
19.	0	12	5	Im. I. sat. ♃
19.	4	5	–	☌ ☿ 2 δ ♉
20.	10	43	–	☌ ☿ 1 ε ♉
20.	23	34	–	☿ greatest elong.
21.	21	34	55	☌ ☽ γ ♎
22.	5	26	49	☉ enters ♋
22.	9	3	13	☌ ☽ ψ ♎
23.	1	23	50	☌ ☽ φ Oph.
25.	6	49	2	○ Full Moon.
26.	2	6	3	Im. I. sat. ♃
26.	8	48	43	☌ ☽ d ♐
28.	16	36	30	☌ ☽ ♅
29.	7	15	4	☌ ☽ ♃
30.	9	48	7	☌ ♂ δ ♋
30.	14	37	8	☌ ☽ λ ♒
31.	13	2	26	☌ ☽ φ ♒

On the 15th of April, there will be an occultation of Aldebaran by the Moon:

	D.	H. ′
Immersion, ...	15	16 37, at 158°
Emersion, ...	...	17 30, at 270

On the 2d of June, there will be an occultation of Jupiter by the Moon:

	D.	H.
Immersion, *centre*, ...	2.	0 59, at 54°
Emersion, *centre*, ...	...	2 4, at 278

On the 9th of June, there will be an occultation of Aldebaran by the Moon:

	D.	H. ′
Immersion, ...	9.	13 16, at 132°
Emersion, ...	...	14 20, at 302

The *angle* denotes the point of the Moon's limb where the phenomena will take place, reckoning from the *vertex* of the limb towards the right hand round the circumference, as seen with a telescope which inverts.

Times of the Planets passing the Meridian, and their Declination.

APRIL.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	11 48	0 57 N.	13 36	13 10 N.	15 56	23 16 N.	8 36	16 48 S.	21 15	14 36 N.	8 29	17 23 S.
5	12 1	3 41	13 39	14 54	15 51	23 37	8 25	16 36	20 59	14 40	8 13	17 21
10	12 13	9 18	13 42	16 58	15 45	24 0	8 8	16 22	20 39	14 43	7 54	17 18
15	12 38	13 48	13 48	18 50	15 39	24 18	7 50	16 8	20 18	14 45	7 35	17 16
20	12 55	17 44	13 53	20 32	15 33	24 32	7 33	15 55	19 58	14 46	7 16	17 14
25	13 10	20 45	13 58	22 0	15 27	24 42	7 17	15 43	19 39	14 46	7 57	17 11

MAY.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	13 19	23 0 N.	14 5	23 25 N.	15 20	24 47 N.	6 55	15 30 S.	19 15	14 45 N.	6 34	17 10 S.
5	13 18	23 38	14 9	24 9	15 15	24 47	6 42	15 22	19 0	14 44	6 19	17 9
10	13 12	23 45	14 16	24 49	15 9	24 42	6 24	15 14	18 43	14 42	5 59	17 8
15	12 56	22 53	14 24	25 12	15 3	24 34	6 6	15 6	18 25	14 38	5 40	17 8
20	12 33	21 6	14 30	25 17	14 57	24 21	5 48	15 0	18 4	14 35	5 21	17 8
25	12 3	19 37	14 36	25 4	14 51	24 3	5 30	14 55	17 44	14 29	5 4	17 9

JUNE.

D.	Mercury. H. ′	Mercury. ° ′	Venus. H. ′	Venus. ° ′	Mars. H. ′	Mars. ° ′	Jupiter. H. ′	Jupiter. ° ′	Saturn. H. ′	Saturn. ° ′	Georgian. H. ′	Georgian. ° ′
1	11 23	17 14 N.	14 43	24 18 N.	14 42	23 31 N.	5 3	14 51 S.	17 17	14 20 N.	4 32	21 8 S.
5	11 3	16 27	14 48	23 37	14 37	23 10	4 48	14 50	17 6	14 15	4 14	21 8
10	10 43	16 11	14 53	22 31	14 30	22 39	4 29	14 50	16 45	14 8	3 56	21 8
15	10 31	16 44	14 57	21 12	14 24	22 4	4 9	14 52	16 26	14 0	3 37	21 8
20	10 27	17 57	15 0	19 40	14 17	21 25	3 49	14 55	16 6	13 50	3 17	21 7
25	10 30	19 31	15 3	17 56	14 11	20 43	3 29	15 0	15 46	13 41	2 56	21 7

Proceedings of the Wernerian Natural History Society.

1331, *Jan.* 22.—Dr Robert Kaye Greville, V. P. in the chair.—Mr John James Audubon (who has spent the winter in Edinburgh) read an account of the White-headed Eagle of America, Aquila leucocephala, and exhibited a splendid engraving of the bird, prepared for his great work, entitled, The Birds of America. The Rev. Dr David Scot then read an essay on the Selavim or Quails of the Bible. After which there was read a letter from an intelligent settler at Swan River, in New Holland, giving a description of the soil and general aspect of the country, which appear nowise so inviting to emigrants as had at first been represented.

Feb. 5.—Henry Witham, Esq. lately V. P. in the chair. The Secretary read an account, communicated by the Rev. Lansdown Guilding of St Vincents, of a new and beautiful species of West Indian Moth, called by him Atticus Wilsonii, (in honour of Mr James Wilson, Librarian of the Society, and a distinguished entomologist). A fine coloured drawing of the perfect insect of both sexes, with the larva and cocoon, was exhibited to the meeting. Professor Jameson then made a communication regarding the Flints found in Banffshire by Mr James Christie, Secretary of the Banff Institution. Nodules were exhibited imbedded in a kind of felspar-clay. The flint has not yet been detected *in situ;* but Professor Jameson thought it not improbable that a portion of the chalk formation may be observed in some of the hollows in that district of country. [See the present Volume of this Journal, p. 163, &c.] The Professor next read a learned essay, by a Fellow of the Royal Societies of London and Edinburgh, on the form of the Ark of Noah, as described in the Pentateuch; shewing that the word *tzohar*, rendered *window* in our translation, rather means *tapering upwards*; and that, with this modification, the form of the Ark was not only admirably adapted for floating, but also for withstanding the shock of waves, although this last quality has been generally denied to it by unscientific commentators. [This paper is printed in the present Number of this Journal, *supra* p. 310, &c.]. At the same meeting, the Rev. D. Scot read a paper on the Alabaster of the ancients.

Feb. 19.—Robert Jameson, Esq. P. in the chair. There was read an essay on the Beacon lights of remote antiquity communicated by Mr Robert Stevenson, civil engineer. Likewise a paper on the influence of rocks on the nature of the vegetation which covers them, communicated by Dr Alexander Murray of Aberdeenshire.

At the same meeting, Mr John James Audubon communicated an interesting and graphic description of a flood of the Mississippi, which he had witnessed during his residence in the western parts of America.

March 5.—Robert Jameson, Esq., P., in the chair. The first paper read was Dr Turnbull Christie's account of the occurrence of hailstorms within the torrid zone, in the peninsula of India. The Rev. Dr David Scot read a learned essay on the Zebi of the Bible, which he proved to be the Mountain Gazelle, and not the Roe, as in our authorised translation.

Dr Greville, V. P., having taken the chair, Professor Jameson stated the general results of accurately kept meteorological tables, shewing the nature of the weather in the Isle of Man from 1824 to 1830. He also communicated a copy of the meteorological register for 1830, kept at Kinfauns Castle, under the direction of Lord Gray; and a similar register, kept at Aberdeen by Mr George Innes. The Professor then laid on the table a copy of a return to an address of the House of Commons relating to sums of money granted for mineralogical purposes in Scotland; from which it appeared, that no part of the money had been granted to this Society, nor to the Edinburgh Museum,—although the printed Parliamentary votes had mentioned the Mineralogical *Society* of Scotland, and the newspapers had stated, that part of the money was for the Edinburgh Museum; but that the whole sum, amounting to upwards of L. 7000, had been paid to Dr John MacCulloch of Woolwich, for a Mineralogical Survey of Scotland, never *until now* heard of by men of science in Scotland. It was remarked, that it would be desirable in Government to cause to be published forthwith the results of this expensive and it seems only *partial survey* of Scotland.

At the same meeting, Professor Jameson communicated a notice in regard to the structure of certain fossil woods from Van Dieman's Land, shewing, that the ancient vegetation had resembled that of the old world, or differed greatly from the present; and read an interesting letter from Mr William Nicol, lecturer on natural philosophy, on the subject of illustrating the structure of woods, fossil and recent, by means of extremely thin slices placed upon glass, and magnified. (See the present Number, p. 361.)

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Meteorological Table.*—Extracted from the Register kept at Kinfauns Castle, N. Britain, Lat. 56° 23′ 30″.—Above the level of the sea 150 feet.

1830.	Morning ½ past 9, *Mean Height of*		Evening, ½ past 8, *Mean Height of*		Mean Temp. by Six's Therm.	Depth of Rain in Garden.	No. of Days.	
	Barom.	Therm.	Barom.	Therm.			Rain or Snow.	Fair
	Inches.	°	Inches.	°	°	Inches.		
January,	29.921	36.742	29.894	35.710	36.903	2.00	12	19
February,	29.597	37.286	29.587	36.607	37.679	2.00	11	17
March,	29.698	45.710	29.687	43.582	45.355	1.20	11	20
April,	29.451	48.400	29.442	45.733	46.800	2.90	15	15
May,	29.663	53.839	29.655	50.258	51.645	3.70	15	16
June,	29.603	56.767	29.626	52.933	54.400	2.50	17	13
July,	29.670	61.226	29.671	57.903	59.581	5.20	17	14
August,	29.595	55.903	29.618	52.839	54.839	5.00	20	11
September,	29.435	53.833	29.475	51.867	53.667	5.00	18	12
October,	29.926	49.581	29.942	48.323	50.129	0.35	4	27
November,	29.465	43.667	29.483	42.367	43.867	3.00	15	15
December,	29.468	36.419	29.468	35.903	36.645	4.00	17	14
Average of the year,	29.624	48.281	29.629	46.169	47.626	36.85	172	193

ANNUAL RESULTS.

MORNING.

BAROMETER. Observations.		Wind.	Inch.	THERMOMETER.	Wind.	
Highest,	1st Jan.	N.	30.53	28th July,	S. W.	73°
Lowest,	16th Nov.	S.	28.73	26th December,	W.	19°

EVENING.

Highest,	1st, Jan.	NE.	30.50	28th July,	NE.	68°
Lowest,	16th Nov.	SW.	28.66	24th December,	NW.	21°

Weather.	Days.	Wind.	Times
Fair,	193	N. & NE.,	25
Rain or snow,	172	E. & SE.,	108
		S. & SW.,	159
	365	W. & NW.,	73
			365

Extreme Cold and Heat by Six's Thermometer.

Coldest, 26th December,	Wind, W.		16°
Hottest, 28th July,	do.	SW.	79°
Mean Temperature for the year 1830,			47° 626

Results of Two Rain Gauges.

	In. 100.
1. Centre of Kinfauns Garden, about 20 feet above the level of the sea,	36.85
2. Square Tower, Kinfauns Castle, 180 feet,	36.85

2. *Thunder-Storms in France.*—The Count de Triston has made observations on the direction of the thunder-storms which have devastated the department of the Lorich for the last sixteen years. The following general inferences have been made by him, respecting the progress and intensity of thunder-storms in plain countries, intersected by shallow valleys. Thunder storms are attracted by forests. When one arrives at a forest, if it be obliquely, it glides along it; if directly, or if the forest be narrow, it is turned from its direction; if the forest be broad, the tempest may be totally arrested. Whenever a forest, being in the path of a thunder-storm, tends to turn it aside, the velocity of the storm seems retarded, and its intensity is augmented. A thunder cloud, which is arrested by a forest, exhausts itself along it, or, if it pass over, is greatly weakened. When a large river or valley is nearly parallel to the course of a thunder storm, the latter follows its direction; but the approach of a wood, or the somewhat abrupt turn of the river or valley, makes it pass off. A thunder cloud attracts another which is at no great distance, and causes it to deviate from its course. There is reason to believe, that the action is reciprocal. A cloud attracted by a larger, accelerates its motion, as it approaches the principal cloud. When there is an affluent cloud, which was committing ravages, it sometimes suspends them on approaching the principal mass, which is perhaps a consequence of the acceleration of its course; but after the union the evil generally increases. Twenty-one thunder-storms, whose course has been distinctly traced, have extended from N.NW. to S.S.W. No destructive thunder-storm has come from any other points of the horizon. Lastly, the position and form of the forest of Orleans, Blois, &c., satisfactorily accounts for the frequency of hail-storms in certain communes, and their rare occurrence in others.

3. *Sudden agitation of the Sea.*—His Majesty's ship Hotspur, in 1813, whilst cruising in the Bay of Biscay, under easy sail, with moderate weather, was in a moment nearly overwhelmed by three successive seas. The quarter-deck bulwarks were carried away, one gun washed overboard, the wheel unshipped, several men lost, and the ship rendered unmanageable, and in imminent danger of foundering, in consequence of the quantity of water shipped. Immediately after, all appeared calm, as if nothing happened; and it was the opinion of those who witnessed this, that it was occasioned by a momentary and very partial agitation of the sea.—*Mr Drummond, Surgeon, R.N.*

4. *Aurora Borealis at Paris.*—The following are the magnetic observations made at the Paris Observatory on the aurora, which was visible here on the night of the 7th January. The aurora caused a deviation of the magnetic needle in variation,

A declination equal to 1° 6′ 47″
In inclination equal to 0° 28′ 00″

N. B.—The variations of the magnetic needle, in declination, can be appreciated to 5 seconds at the Paris Observatory. Throughout Scotland the Polar lights, from their brilliancy, have excited intense interest among the populace;—but, strange to say, the natural philosophers of Scotland, who are well provided with magnetical apparatus, sleep on without once thinking of tracing out the connection of these interesting phenomena with the magnetic needle.

GEOLOGY.

5. *Gold Mines in the Uralian Mountains.*—The produce of the Ural mines amounted, in 1827, to L. 651,420; in 1828, to L. 672,416. Gold is also found in the Rhine; but the quantity is so scanty, that the washer considers it a good day's work, if he succeed in collecting to the value of five or six shillings. From the official accounts of the yearly produce obtained from that stream in the Grand Duchy of Baden, we observe that the value was, in 1821–2, L. 603; 1826–7, L. 808; 1827–8, L. 943. The last produce, small as it may appear, for it scarcely exceeded 17 pounds in weight, shewed so considerable an increase upon preceding years, that a great impulse

was given to this branch of industry in Baden, and the harvest has become still more productive.

6. *Lightning Tubes.*—In the vicinity of the old castle of Remstein, near Blenhenburg, which stands on a picturesque series of rocks, belonging to the greensand or quadersandstone formation, in a loam land, there have been found, this summer, very firm and long vitreous tubes (Bliteröhren). From a branch in the upper part, two branches go off, some of which are ten feet long, and from these proceed three small branches.—*Literary Gazette*, January 15. 1831.

7. *Temperature of some Mines in Cornwall.*—The following interesting observations were made by Robert Were Fox, Esq. of Falmouth, and communicated to the Royal Geological Society of Cornwall:—At Tingtang copper-mine, in the parish of Gwennap, at the bottom of the engine-shaft, which is in Killas (clayslate), and 178 fathoms deep, the water, two months ago, was at the temperature of 82°. In 1820, when the shaft was 105 fathoms deep, the temperature of the water was 68°; thus an increase of 14° has been observed in sinking 73 fathoms, which is equal to 1° in 5 fathoms. At Huel Vor tin-mine, near Helston, the water was 69°, at the bottom of a shaft 139 fathoms deep, in the year 1819. It is now 209 fathoms deep. and the temperature is 79, which gives an increase of 1° in sinking 7 fathoms. This part of the mine is in Killas. The highest temperature of the water, at the bottom of Poldice copper and tin mine, in the parish of Gwennap, in 1820, which was then 144 fathoms under the surface, was 80°. It is now 176 fathoms deep, and the temperature is 99°; and, in a cross level, 20 fathoms further north, the water is 100°. The two last mentioned temperatures are the highest hitherto observed in any of the mines of Cornwall; and the increase is equal to 19° in one case, and 20° in another, in sinking 32 fathoms, or 1° for 1½ fathom. Three persons only were employed at the time near each of these stations, and the water pumped up from this part of the mine was estimated at 1,800,000 gallons in twenty-four hours; and it was found to contain a considerable quantity of common salt in solution.

8. *Volcano in New Zealand.*—Accompanying a specimen of

volcanic ashes sent to me by Colonel Lindsay of Sydney, is a notice to the following effect: This substance is found on what is called *White Island*, from the ashes that continually fall from a volcano, at present in a state of activity, and which has been long in the same condition. It is about three miles round, and lies opposite to the Bay of Plenty, between the river Thames and the East Cape, and from twenty to thirty miles from the mainland of New Zealand. When this island was last visited, it presented a frightful display of flame and smoke from the crater of its volcano At the foot of the hill in which the volcano is situated, there is a lake of *boiling sulphur*, and all around the lake the ground is encrusted with sulphur. The natives say the volcano runs under the sea, and bursts out again in the interior of New Zealand, about twenty miles from the shore, in a district where there is a large hot lake in the waters, of which the natives cook their provisions.—Edit.

9. *Map of the Puy de Dome.*—A map of the famous mountain the Puy de Dome, in twelve sheets, is now in preparation, by Bussy of Paris.

10. *Diamond in the Coal formation.*—The diamond is said to have been found in the coal formation in India.

11. *Splendid Specimen of Megatherium.*—A perfect skeleton of the megatherium, exceeding in size the splendid specimen preserved in the Cabinet of Natural History in Madrid, has been lately discovered 126 miles south of Buenos Ayres. This remarkable specimen of antediluvian zoology is now in the possession of Woodbine Parish, Esq., Consul-General at Buenos Ayres, who intends to bring it with him to Europe.

12. *Slates of the Tarentaise belong to the Jura Formation.*—All the slates, conglomerates, and sandstones of the Tarentaise, formerly considered as transition, are now arranged with the oolite or Jura formation.

13. *Decrepitating Common Salt. Condensation of Gas in it.*—M. Dumas has examined and described a very curious effect which occurred when some rock-salt obtained from the mine of Wieliczka in Poland, and given to him by M. Boué, was put into water. It decrepitated as it dissolved in the water, and gradually evolved a sensible portion of gas. The bubbles of gas were sensibly larger when the decrepitations were stronger, and

the latter frequently made the glass tremble. This salt owes its property of decrepitating to a gas which it contains in a strongly compressed state, although no cavities are sensible to the eye. When the experiment was made in perfect darkness, no light was disengaged. The gas disengaged is hydrogen, slightly carbonate; when mixed with air it burns at the approach of a light. This disengaging of gas will assist in explaining the numerous accidents which have happened from fire-damp in salt mines. Several portions of the salt were nebulous, others were transparent. The nebulosities indicated the existence of numerous minute cavities, probably filled with condensed gas, and, in fact, a nebulous fragment dissolved in water, gave more gas than an equal sized fragment of the transparent salt. This new fact, described by M. Dumas, shews how frequent, in the course of geological accidents, are the phenomena to which are due the accumulation of gas in the cavities of mineral substances, and how varied are the substances upon which these phenomena have been exerted. M. Dumas has endeavoured to reproduce salt, having the power of decrepitating in water, like that described.

14. *Interesting discovery of Fossil Animals.*—There has been lately sent to the Garden of Plants, a collection of fossil bones, from the lacustrine deposits of Argenton (Indre), consisting of five or six species of Lophiodon, from the size of a large rabbit to that of a horse; also species of the genus Anthrocotherium, of the Trionyx, and Crocodile. Some recent discoveries in the diluvian ossiferous deposite of Chevilly (Loiret) of the bones of the extremities of the animal called Gigantic Tapir by Cuvier, shews that this animal, by the test of its osteology, is closely allied to the living tapir, although equalling, if not exceeding, the rhinoceros. The Indri and Loiret are two departments in the central districts of France.

15. *Dr Turnbull Christie.*—Dr Turnbull Christie, who has been appointed to examine the geology of the Presidency of Madras, by the India Company, has left Edinburgh for our Eastern Empire. He travels through France and Italy, embarks for Alexandria,—from thence he visits the Holy Land, Mount Sinai,—sails down the Red Sea for Bombay, and from thence by land or sea to Madras. From the varied talent and infor-

mation of this accomplished individual, his indomitable zeal and activity, and experience of eastern climate and travelling, we anticipate great accessions to our knowledge of the natural history of the various countries he visits. He takes with him a painter for the purposes of zoology, comparative anatomy, botany and geology, and a complete set of instruments for ascertaining the nature of the meteorological and hydrographical phenomena that may present themselves to his attention.

16. *New President of the Geological Society.*—We are happy to learn that Roderick Impey Murchison, Esq. has been unanimously chosen President of the Geological Society of London. This gentleman, from his experience, skill, zeal, and activity in geology, will, we are confident, prove himself a worthy successor to such men as Greenough, Fitton, Buckland, Sedgwick, &c.

MINERALOGY.

17. *Recent Formation of Zeolite.*—Stilbite, mesotype, and apophyllite, appear almost always as a newer formation in the cavities of amygdaloid, and along with these calcareous spar. The formation of zeolite through the action of atmospheric water on dolerite, seems still to be going on. We observe it forming in hollows of a conglomerate, in which zeolite plays the part of calcareous sinter. Springs deposite a similar zeolite sinter; and when, in the summer, the brooks dry up, their whole bed appears white. In deep caves, where, during lower temperature and greater humidity of the air, scarcely any evaporation takes place, I found a matter partly gelatinous, partly crystalline, which proved the continued production of zeolite.—*Forchammer.*

18. *A New Metal discovered.*—Mr Dulong read, on the 7th of February last, to the French Institute, a letter from Berzelius, which announces the discovery of a new simple substance by Mr Sestrom, director of the mines of Fahlun in Dalecarlia. Mr Sestrom being engaged in examining an iron, remarkable for its softness, discovered in it a substance, which appeared to him to be new, but in such small quantity, that he could not determine with accuracy all its properties. Afterwards, however, he found it more abundantly in the scoriæ of the iron,

and was thus enabled to prove that the substance in question was a *new metal*, to which he gives the name *Vanadium*, after an ancient Scandinavian deity. We have had communicated to us the following additional notice. Humboldt presented to the Institute specimens of Vanadium, the new metal recently discovered in the iron of Estersholm by Mr Sestrom, and which also exists in Mexico in a brown ore of lead of Zimapan. M. del Rio, Professor in the School of Mines of Mexico, had extracted from that ore a substance, which, to his apprehension, resembled a new metal, to which he gave the name of *Erythronium*. M. Collet Descotils, to whom he sent a specimen, could not agree in erythronium being a simple substance, and believed he had demonstrated that it was an impure chrome. It would appear that Professor del Rio agreed in this opinion, and there was not longer any idea of its being a new metal. But since the discovery of Sestrom was known to Voller, he, struck with the resemblances which exist between the properties of vanadium and that which the Mexican chemist attributes to his erythronium, has repeated the analysis of the brown ore of lead of Zimapan, and from which he has obtained a simple body, perfectly identical with that of the iron ore of d'Esterholm. It is worthy of remark that so rare a metal should have been discovered in two places so far asunder as Scandinavia and Mexico.

ZOOLOGY.

19. *Four-spined Stickleback.*—A variety of the Stickleback (*Gasterosteus aculeatus*) with four spines on the back, was discovered in a pond in the Meadows by Mr John Stark, in September 1830. The common three-spined stickleback was numerous in the same pond; and, of a number taken in a net at random, about one in ten or twelve proved to be of the four-spined variety. This variety (or perhaps species), does not appear to have been previously noticed. It is somewhat smaller than the common three-spined stickleback when full grown, the specimens procured not exceeding one-fourth of an inch in length. The arrangement of the spines is also different, being placed in twos at regular distances, corresponding to the length of the spines. The two anterior spines are much longer than the other two, the second longest.—*Stark.*

20. *Himala Ornithology.*—We learn, in regard to the ornitho-

logy of the Himala, that its principal features are the brilliancy of plumage of the Gallinæ—the size and power of the Accipitres—and the almost infinite number of the Pies.

BOTANY.

21. *Crystals in Living Vegetables.*—Various naturalists have taken notice of the appearance of crystals in the internal parts of vegetable tissues, but nothing very explicit and certain has been stated respecting them. M. Turpin has discovered, in the cellular tissue of an old trunk of the Cereus Peruvianus, in the Garden of Plants at Paris, where it had been growing one hundred and thirty years, an immense quantity of agglomerations of crystals of oxalate of lime. They are found in the cellular tissue of the pith and bark. They are white, transparent, four-sided prisms, with pyramidal terminations, collected in radiant groups.

22. *Native Country of Maize, or Indian Corn.*—This grain, so important to the agricultural interests of the United States, appears to be of uncertain origin. Fuchs very early maintained that it came from the east; and Mathioli affirmed that it was from America. Regmir and Gregory have presented fresh arguments in favour of its eastern origin. Among them is the name by which it has been long known in Europe, *Blé de Turquie*; and varieties, it is said, have been brought from the Isle of France, or from China. Moreau de Jonnés, on the contrary, has recently maintained, in a memoir read before the Academy of Sciences, that its origin was in America. The name *Blé de Turquie* no more proves it to be of Turkish origin, than the name of the Italian Poplar proves that that tree grew wild in Italy. It can only signify that it spread from Turkey into the neighbouring countries. Its general cultivation in southern Europe, and the production of some new varieties, proves nothing with regard to the country of the species. In favour of its American origin, is the fact that it was found in a state of cultivation, in every place where the first navigators landed. In Mexico according to Hernandez, and in Brazil according to Zeri; and that in the various countries it had proper names, such as *Maize, Flaolli,* &c.; while, in the Old World, its names were either all of American origin, or names of the neighbour-

ing region, whence it was immediately derived; and that, immediately after the discovery of America, it spread rapidly in the Old World, and soon became common, a fact not reconcileable with the idea of its former existence there. To these proofs Aug. de Saint Hilaire has added another. He has received from M. de Larranhaga of Monte Video, a new variety of maize, distinguished by the name of Tunicata; because, instead of having the grains naked, they are entirely covered by the glumes. This variety is from Paraguay, where it is cultivated by the Guaycurus Indians, a people in the lowest scale of civilization, and where, according to the direct testimony of one of them, it grows in the humid forests as a native production.

GEOGRAPHY.

23. *Tables for Converting French Toises and Metres into English Feet, and the contrary.*—Readers of philosophical works and foreign journals frequently meet with dimensions expressed in French measures. To enable such to convert them readily into English measures, the following Tables have been computed. The lengths of a Toise and a Metre in English measure, which are the foundation of the Tables, have been taken from Baily's *Astronomical Tables and Formulæ*, and he deduced them from their lengths, as given in the *Base du Système Métrique*, vol. iii. and Captain Kater's paper on the Length of the French Metre in the Phil. Trans. for 1818.

TABLE I.

1 French Toise	= 1.949036 French Metres	= 6.394950 English Feet.
1 French Metre	= .513074 Toise	= 3.280899 English Feet.
1 English Foot	= .156373 Toise	= .304794 French Metre.

TABLE II. FOR CONVERTING FRENCH TOISES INTO ENGLISH FEET.

Toises.	English Feet.	Toises.	English Feet.	T.	English Feet.	T.	Eng. Feet.	T.	Eng. Feet.	T.	Eng. Feet.
1000	6394.95	100	639.50	10	63.95	1	6.39	.1	.64	.01	.06
2000	12789.90	200	1278.99	20	127.90	2	12.79	.2	1.28	.02	.13
3000	19184.85	300	1918.49	30	191.85	3	19.18	.3	1.92	.03	.19
4000	25579.80	400	2557.98	40	255.80	4	25.58	.4	2.56	.04	.26
5000	31974.75	500	3197.48	50	319.75	5	31.97	.5	3.20	.05	.32
6000	38369.70	600	3836.97	60	383.70	6	38.37	.6	3.84	.06	.38
7000	44764.65	700	4476.47	70	447.65	7	44.76	.7	4.48	.07	.45
8000	51159.60	800	5115.96	80	511.60	8	51.16	.8	5.12	.08	.51
9000	57554.55	900	5755.45	90	575.55	9	57.55	.9	5.76	.09	.58

TABLE III. FOR CONVERTING FRENCH METRES INTO ENGLISH FEET.

Metres.	English Feet.	Metres.	English Feet.	M.	English Feet.	M.	Eng. Feet.	M.	Eng. Feet.	M.	Eng. Feet.
1000	3280.90	100	328.09	10	32.81	1	3.28	.1	.33	.01	.03
2000	6561.80	200	656.18	20	65.62	2	6.56	.2	.66	.02	.07
3000	9842.70	300	984.27	30	98.43	3	9.84	.3	.98	.03	.10
4000	13123.60	400	1312.36	40	131.24	4	13.12	.4	1.31	.04	.13
5000	16404.50	500	1640.45	50	164.04	5	16.40	.5	1.64	.05	.16
6000	19685.40	600	1968.54	60	196.86	6	19.69	.6	1.97	.06	.20
7000	22966.29	700	2296.63	70	229.66	7	22.97	.7	2.30	.07	.23
8000	26247.19	800	2624.72	80	262.47	8	26.25	.8	2.62	.08	.26
9000	29528.09	900	2952.81	90	295.28	9	29.53	.9	2.95	.09	.30
10000	32808.99										

EXAMPLE of TAB. II.—Convert 2205.23 Toises (height of Mont Blanc above the Lake of Geneva) into English Feet.

Toises.		*Eng. Feet.*
2000	=	12789.90
200	=	1278.99
5	=	31.97
.2	=	1.28
.03	=	.19
2205.23	=	14102.33

EXAMPLE of TAB. III.—Gay Lussac ascended with a balloon to the height of 7028.3 Metres, as determined by a barometer,—convert this into English Feet.

Metres.		*Eng. Feet.*
7000	=	22966.29
20	=	65.62
8	=	26.25
.3	=	0.98
7028.3	=	23059.14
	=	4 Miles 1939 Feet.

NEW PUBLICATION.

Sections and Views Illustrative of Geological Phenomena. By HENRY DE LA BECHE, F. R. S. F. G. S. London, 1830. 4to.

WE recommend to the particular attention of the numerous cultivators of geology throughout Britain, these valuable sections and views. They are selected with judgment from many expensive works, which few have an opportunity of purchasing, and many of never seeing at all.

List of Patents granted in England from 27th November to 13th December 1830.

1830.

Nov. 27. To J. REVERE, Weybridge, Surrey, M. D., for "a new and improved method of protecting iron chain-cables, iron-boilers, and iron tanks, from the corrosion produced upon them by the action of water."

29. To W. CHURCH, Haywood House, Warwickshire, for "certain improvements in apparatus applicable to propelling boats and driving machinery by the agency of steam, part of which improvements are also applicable to the purposes of evaporation."

1830.

Dec. 6. To H. Blundell, Kensington-upon-Hull, for "improvements in a machine for grinding or crushing seeds, and other oleaginous substances, for the purpose of abstracting oil therefrom, and which machine, with certain improvements or alterations, is applicable to other useful purposes."

To R. Dalglish, Glasgow, calico-printer, for "improvements in machinery or apparatus, for printing calicoes and other fabrics."

To R. Edwards, Deusbury, Yorkshire, for "an improvement on, or substitute for, glass, sand and emery, and other scouring paper or substances."

To Captain S. Brown, Biliter Square, London, for "certain improvements in the means of drawing up ships and other vessels from the water on land, and for transporting or mooring ships, vessels, and other bodies, on land, from one place to another."

To J. G. Lacy, Camomile Street, London, gun manufacturer, and S. Davis, East Smithfield, gun-lock maker, for "a certain improvement or improvements in the construction of guns and fire-arms."

13. To J. Dickson, Wolverhampton, and J. Vardy of the same place, for "certain improvements in cocks for drawing off liquids."

Dec. 6. To T. Walmsley, Manchester, manufacturer, for "improvements in the manufacture of cotton, linen, silk, and other fibrous substances, into a fabric or fabrics applicable to various useful purposes."

To W. Needham, Longour, Staffordshire, for "certain improvements in machinery for spinning, doubling, and twisting silk and other fibrous substances."

To S. Parlour, Croydon, Surrey, for "certain improvements on lamps," which he denominates "Parlour's improved Table Lamp."

13. To J. L. Benham, Wigmore Street, Middlesex, ironmonger, for "certain improvements on shower and other baths, communicated by a foreigner.

To R. Witty, Basford, in the parish of Wolstanton, Staffordshire, engineer, for "certain improvements in apparatus for propelling carriages, boats, or vessels for other purposes, by the power of steam.

List of Patents granted in Scotland from 20th December 1830, *to 4th March* 1831.

1830.

Dec. 20. To Thomas Walmsley of Manchester, manufacturer, for the invention of "improvements in the manufacture of cotton, linen, silk, and other fibrous substances, into a fabric or fabrics applicable to various useful purposes."

To CHARLES STUART COCHRANE of Great George Street, Westminster, Esq. a Commander in the Royal Navy, for the invention, communicated to him by a foreigner residing abroad, of "certain improvements in the preparing and spinning of cashmere wools."

To ROBERT DALGLISH, jun. of Glasgow, calico-printer, for the invention of "improvements in machinery, or apparatus for printing calicoes and other fabrics."

28. To JOHN HALL, jun. of Dartford, in the county of Kent, engineer, for the invention, communicated to him by a foreigner residing abroad, of "a machine, upon a new and improved construction, for the manufacture of paper."

1831

Jan. 14. To WILLIAM NEEDHAM of Longour, in the county of Stafford, gentleman, for the invention of "certain improvements in machinery for spinning, doubling, and twisting silk, and other fibrous substances."

18. To FRANCIS MOLINEUX of Hampstead, in the county of Middlesex, gentleman; and WILLIAM BUNDY of Kentish Town, in the same county, engineer, for the invention of "certain improvements in machierny for spinning and twisting silk and wool, and for roving, spinning, and twisting cotton, flax, hemp, and other fibrous substances."

(In place of a former one) To JOHN ERICKSON of the New Road, London, engineer, for the invention of "an improved engine for communicating power for mechanical purposes."

19. To SAMUEL CLEGG of No. 16, Sidmouth Street, Gray's Inn Lane, in the county of Middlesex, civil-engineer, for the invention of "an improved gas meter."

Feb. 2. To THOMAS BULKELEY of Upper Gloucester Street, New Road, in the county of Middlesex, doctor of medicine, for the invention of "a method of making or manufacturing candles."

Feb. 18. To JAMES THOMSON of Spencer Street, Goswell Street Road, in the county of Middlesex, gentleman, for the invention of "certain improvements in making or producing printing-types."

To RICHARD ROBERTS of Manchester, in the county of Lancaster, civil-engineer, for the invention of "a certain improvement, or certain improvements, in the mechanism employed to render self-acting machines, known by the name of Mull-Billy-Jenny-Jack Frame, or stretching frame, and all machines of that class, whether the said machines be used to rove, slub, or spin cotton, or other fibrous substances."

To AUGUSTUS GRAHAM, citizen of the United States of America, but now residing in West Street, Finsbury, in the city of London, gentleman, for an invention, communicated to him by a foreigner residing abroad, of "certain improvements in the application of springs to carriages."

To WILLIAM WEDD TAXFORD of Boston, in the county of Lincoln, miller, for the invention of "a machine or apparatus for cleansing or purifying wheat, grain, or other substances."

To Richard Edwards of Dewsbury, in the county of York, leather and flock seller, for the invention of "an improvement on, or a substitute for glass, sand, emery, and other scouring paper or substances."

18. To Joel Benedict Nott, of Schenectady, in the State of New York, now of Barry Street, St James's, in the county of Middlesex, for the invention, communicated to him by a foreigner residing abroad, of "certain improvements in the construction of a furnace or furnaces for generating heat, and in the apparatus for the application of heat to various useful purposes."

21. To Bartholomew Redfern of Birmingham, in the county of Warwick, gun-maker, for the invention of "a lock, break-off, and trigger, upon a new and improved principle, for fowling-pieces, muskets, rifles, pistils, and small fire-arms of all descriptions."

23. To John Wallace, brassfounder in Leith, for the invention of "an improvement or improvements upon the safety-hearths for the use of vessels.

Mar. 2. To John Macdowall of Johnston, near Paisley, for the invention of "certain improvements on the pistons, valves, and boilers of steam-engines."

To William Morgan of York Terrace, Regent's Park, in the county of Middlesex, Esq., for the invention of "certain improvements in steam-engines."

3. To Jeremiah Grime junior, of Bury, in the county of Lancaster, copper-plate engraver, for the invention of "a certain method of dissolving snow and ice on the trams or railways, in order that locomotive steam engines and carriages, and other carriages, may pass over railroads, without any obstruction or impediment from such snow or ice."

The Editor hopes to get all the Memoirs and Registers of the Weather, still unpublished, inserted in next number of Journal.

ADDENDUM.

[The Report regarding the New Holland Fossil Bones not having reached us in time for insertion along with the account of the Caves, we, rather than delay it until next Number, place it here, although somewhat out of place, considering its importance as a sufficient apology for this irregularity.]

On the Fossil Bones found in the Bone-Caves and Bone-Breccia of New Holland. By Professor JAMESON.

MY friend and former pupil Dr Adam, Fellow of the Royal College of Physicians, having, after much labour, cleared the teeth and bones from the stony and earthy matter in which they were enveloped, we endeavoured to determine the animals to which they belonged. The general result of our examination was, that some of the teeth were those of the *wombat,* some belonged to the *kangaroo,* others we could not refer, from want of means of comparison. One bone, from its great size, particularly arrested our attention, from its appearing to belong to an animal larger than any of the living species in the Australian world. It appeared, on comparing it with the splendid skeleton of the hippopotamus in the Museum, to resemble the radial bone of that animal.

That every justice might be done to the interesting collection sent to me from New Holland, I had it conveyed to London to my friend Dr Turnbull Christie, requesting him to submit the specimens to a distinguished and experienced anatomist, Mr Clift, of the College of Surgeons. That gentleman, with the utmost readiness, undertook to give me his opinion in regard to the bones and teeth, and we have just received from him the following very interesting notice in regard to them.

Report by Mr Clift, of the College of Surgeons, London, in regard to the Fossil Bones found in the Caves and Bone-Breccia of New Holland.

No. 1. Approaches very nearly in form to the metacarpal bone of an ox, but much larger. It also bears a great resemblance to the *radius* of Hippopotamus. (It does not belong to the elephant, being too large for its length).

No. 2. Right side of the lower jaw of a *Dasyurus* *.
Anterior part of left side, upper jaw,—*Wombat.*
Extremity of canine tooth, left side of lower jaw,—*Dasyurus.*

No. 3. Left side, lower jaw,—*Wombat.* (Box B.)

No. 4. Two lower extremities of femora of Wombat, apparently; and other cylindrical bones, uncertain.

Box A. Right incisor, upper jaw,—*Wombat.*
Right incisor, lower jaw,—*Young Kangaroo.*
Portion of incisor,—*Wombat.*
Portion of incisor, upper jaw,—*Do.*
Molaris, upper jaw,—*Do.*
Right incisor, lower jaw,—*Kangaroo.*
Portion of base of incisor, lower jaw,—*Do.*
Molaris, right side, lower jaw,—*Wombat.*
Two-thirds of a molaris, upper jaw,—*Do.*
A molaris, left side, upper jaw,—*Do.*
A portion of a molaris,—*Do.*
Probably portion of an incisor,—*Do.*
Probably a portion of the anterior extremity of lower jaw,—Kangaroo.
Apparently a portion of incisor, and of upper jaw,—Wombat.
Apparently a posterior molaris, of upper jaw,—Kangaroo.

No. 5. Elbow-joint of *Wombat,*—(Humerus and ulna).
Head of Tibia and fibula,—apparently young kangaroo.
Portion of the pelvis,—Of the same.
Upper portion of the left femur of a Wombat?—(is very like it.)
Other specimens doubtful.

No. 6. Portion of the pelvis of a very large *Kangaroo.*

No. 7. Two portions of femur apparently Wombat. They correspond very exactly with the femur of that animal.
Portion of the upper end of the fibula of a *large Kangaroo.*
Portion of probably the femur of ditto.
Other specimens doubtful.

* The *Dasyurus* (the animal called *Devil* by the early settlers) is said to be at present a native of Van Diemen's Land only.

No. 8. Apparently part of the tibia of a Kangaroo.

No. 9. Breccia with fragments of bones. One portion contains what are probably portions of the supernumerary or spurious metatarsal bones and phalanges of a Kangaroo.

No. 11. Portion of upper jaw, probably of a Dasyurus.

No. 15. Left side of upper jaw of *an adult Kangaroo.*
Portion of upper jaw, left side, with the 2d molaris,—*Do.*
Left side, lower jaw, *Kangaroo.*

No. 16. 2. Part of right side lower jaw, *Kangaroo.*
3. Portion of left side upper jaw,—*Do.*
4. Two molares upper jaw,—*Do.*
5. Upper jaw left side,—*Do.*

No. 18. 3 portions of jaws. (Viverra? uncertain.)

No. 19. The terminal phalanx of the toe of a *Kangaroo,* (the claw).
First dorsal vertebra,—Wombat? apparently.
Right os calcis wanting the epiphysis.—Kangaroo?
Rib portion of 4th or 5th, Do.

No. 20. Box C. Two posterior molares, right side upper jaw,—*Dasyurus.*

No. 21. Antepenultimate caudal vertebra of a *Kangaroo.*
Another caudal vertebra, nearer sacrum,—*Do.*
Another, about the tenth from the sacrum,—*Do.*

No. 22. Portion of *apparently* lower jaw with the fang of an incisor, Kangaroo?

No. 26. Apparently the middle of the os femoris of a Wombat.
Other doubtful fragments.

No. 27. *Apparently* a portion of the right tibia near its middle,—*Kangaroo.*

I believe there can be little or no doubt respecting the identity of all the specimens that are in *Italics,* having given them all the attention that time and circumstances permitted.

W. Clift.

From the geological characters of the caves and bone-breccia, the mode of distribution of the bones in the caves, and the nature of the teeth and bones themselves, it follows,

1. That these caves agree in character with those in Europe.

2. That the bone-breccia exhibits the same character as the varieties of that rock found in different parts of the European continent and islands.

3. That New Holland was, at a former period, distinguished from the other parts of the world, by the same peculiarities in the organization of its animals, which so strikingly characterize it at the present day.

4. That the large bone resembling the radial bone of the hippopotamus, shews that Australia formerly possessed animals much larger than any of the present existing species, equalling or even exceeding in magnitude the hippopotamus: a fact of high importance, when we recollect that the quadruped population of New Holland is at present but meagre, the largest species being the kangaroo.

5. That the bone caves and bone-breccia contain, along with animals at present known, others that appear to be extinct, as is the case with the caves and breccia of Europe.

6. That the same agent or agents that brought together the remains of animals met with in bone-caves and bone-breccia in Europe, operated on New Holland.

7. Lastly, that the animals in the Australian caves and breccia were destroyed and became fossil, if not at the same precise time as the European, during a similar series of geological changes.

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